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(FOUO 3/82)

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LIFE SCIENCES

BIOMEDICAL AND BEHAVIORAL SCIENCES

(FOUO 3/82)

CONTENTS

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BIOACOUSTICS OF INSECTS

Moscow BIOAKUSTIKA NASEKOMYKH in Russian 1981 (signed to press 14 May 81) pp 2-8, 217-226, 256

[Introduction, article, conclusion and table of contents from book "Bioacoustics of Insects" by Rustem Devletovich Zhantiyev, Department of Entomology, Moscow State University, Izdatel'stvo Moskovskogo universiteta, 1800 copies, 256 pages]

[Text] This monograph submits the results of studying acoustic communication systems of insects. It describes the structure and functions of acoustical organs, physical characteristics and adaptive properties of acoustical signals. The latest data are submitted on the structure and functions of hearing organs and mechanisms of processing acoustical information in the central nervous system of insects. Much attention is given to the problem of identifying acoustical signals and localizing the source of sound. There is discussion of the possibility of using sounds to control insect behavior. It is intended for workers, graduate and undergraduate students specializing in entomology, physiology, biophysics and bionics. References 445; figures 88, tables 12, appendix 6 tables.

Introduction

Bioacoustics is one of the new directions of research developing on the boundary of biological and physical sciences. It is usually defined as the science of acoustical signaling and orientation of animals. Both of these phenomena play an extremely important and diverse role in vital functions of most animals; for this reason, a wide spectrum of acoustical, mathematical and biological methods is used to study them. The results of bioacoustical studies are of first and foremost importance to the solution of many problems confronting such biological disciplines as systematics, ecology, ethology, neurophysiology and genetics. Some of the advances in bioacoustics are used for bionic studies and solving applied problems related primarily to the control of behavior of animals that are of economic importance.

The conditions for inception of bioacoustics existed long ago, since studies in this direction were pursued for many decades; however, the First Bioacoustics Congress, which convened in the United States in 1956, is generally considered the official beginning of its existence.

Of course, one can view insect bioacoustics as a part or section of general bioacoustics. The goals and tasks of this direction are largely determined by the

specifics of the insect class. In assessing it as the object of bioacoustic studies, one must take into consideration three circumstances. In the first place, insects do not use sound for active ranging (echoranging), while heterospecific communication did not obtain significant development in them, so that researchers can concentrate mainly on the study of intraspecific communication systems. In the second place, these systems appear numerous times in insects and independently in different taxons; they are notable for remarkable diversity and, in spite of the conceptions that prevailed until recently, they are extremely widespread. In the third place, insects are the only group of terrestrial invertebrates in whom sonic signaling underwent rather significant development, and since its inception is apparently referable to the Permian period (Sharov, 1968), it can be assumed that acoustical communication systems reached considerable refinement in the course of prolonged evolution.

On the whole, this form of communication plays a very large part in vital functions of many insects; it is instrumental in encounters between specimens of the opposite sex, maintaining reproductive isolation of close species, regulation of intrapopulation and intrafamily relations. In addition, some insects use sounds as protection against enemies and for detection of prey.

All of this circumstances determine the importance of bioacoustic studies and their intensive development in the last few decades. In order to gain an idea about the theoretical and practical implications of such work, it is enough to list the entomological and general biological problems, in work on which bioacoustical data play a considerable and, sometimes, deciding role.

In this regard, it must be noted, first of all, that in the course of acoustical communication and orientation insects solve problems that are as difficult as those of vertebrate animals, but they do this on a different morphofunctional basis. For this reason, the results of studying their acoustical systems constitute necessary and interesting material for comparative studies in the fields of morphology, physiology, ethology and ecology of animals.

The importance and place of bioacoustics in entomology are attributable chiefly to the fact that acoustic signaling is directly related to insect reproduction and intrapopulation relations. This explains the heightened interest of ecologists and ethologists in acoustic studies. At the present time, it is growing increasingly obvious that the most important patterns of distribution of insects in biotopes, regulation of population density, dynamics of population size, migration, etc., could not be studied without consideration of acoustical communication systems. Knowledge of the "language," by means of which many insects communicate during contact or at considerable distances from one another, makes it possible to adopt a different approach to the study of their behavior during reproduction, competitive relations, establishment of rank (ranking), protection against predators, spatial orientation and other ethological problems.

Animal bioacoustics is equally important to the study of mechanisms of species formation, particularly in those for whom sonic signals serve as the main isolating factor. Species-specificity and stability of sonic signals makes it possible to use them as reliable taxonomic characters, which are needed to solve such complex problems as differentiation between twin-species, determination of

species status, degree of similarity of close taxons, etc. For this reason, some characteristics of sounds have found a firm foothold in systematics concerned with the study of insects with well-developed communication systems (Orthoptera, Cicadidae and others).

The vast area of insect bioacoustics related to the study of processes of receiving and processing acoustical information is, in essence, a part of physiology of sensory systems. For this reason, the study of auditory analyzers of insects helps disclose mechanisms that permit identification of conspecific signals and orientation in relation to the sound source, and it contributes many new elements to conceptions of rhythmic processes in the central nervous system, integrative functions of some parts of the brain, interactions of different analyzers, etc.

Investigation of acoustical communication systems of insects is of both theoretical and practical importance. Knowledge of the principles of organization of these systems enables us, on the one hand, to use the discovered patterns for development and refinement of technical systems (primarily acoustical, direction finding, radio measuring) and, on the other hand, to gain information about vital functions of harmful insects or actively influence their behavior. As a result of these studies, devices and equipment could be developed for the detection, estimation of number, diagnosis and monitoring the physiological state of pests, as well as acoustic repellents and attractants.

There are very many articles and several surveys dealing with descriptions of various aspects of organization and function of different elements of acoustical communication systems of insects (Busnel, 1955, ed.; Haskell, 1961; Busnel, 1963, ed.; Alexander, 1967; Bennet-Clark, 1975a; Elsner, Huber, 1973; Michelsen, 1974; Michelsen, Nocke, 1974; Elsner, Popov, 1978, and others). No comprehensive description of these data could be offered in this book, nor was it included in our objective. At the same time, analysis of literature sources shows that most works dealing with bioacoustics converge on two main problems--recognition and localization. The reason for the increased interest of many researchers in these problems is that insects solve essentially two main problems in the course of acoustical communication and orientation: they recognize conspecific communication signals and determine the spatial position of the sound source. For this reason, we have tried to discuss in this book primarily material that enables us to come as close as possible to understanding the mechanisms involved in recognition and localization of sonic signals. The second and third sections are concerned with these problems. Section 1 describes the main components of acoustical communication systems. Data on some of them are submitted in a generalized form, but many aspects of their organization are discussed in greater detail* in subsequent chapters.

This book was based on the results of 15 years of studies pursued by this author in the department of entomology, Biology Faculty of Moscow State University.

*We virtually fail to touch upon audio signaling of social insects in this book, since a summary of the literature on this subject is given in the monograph of Ye. K. Yes'kov (1979).

This author expresses his profound gratitude for valuable advice and assistance to Prof G. A. Mazokhin-Porshnyakov, Prof N. P. Naumov, Prof S. N. Rzhevkin, N. N. Dubrovin, I. N. Kalinkina, O. S. Korsunovskaya, A. G. Chernyy and V. S. Chukanov, and expresses his appreciation to A. V. Popov, Prof F. Huber, Prof K. Kalmring, Dr. J. Rheinlaender, Dr. H.-G. Rehbein and Dr M. J. Samways who kindly furnished drawings from their works.

Applied Problems of Insect Bioacoustics

At the present time, it is difficult to determine when the idea of using acoustic vibrations to control harmful insects appeared. The first attempts to use acoustical methods to solve applied entomological problems yielded encouraging results. Thus, as far back as 1935, an instrument was designed in Germany to determine latent infestation of wood by the house longhorn beetle (Schwarz et al., 1935); in Canada, a device was developed and successfully tested for chasing the beet webworm away from crops (Belton, Kempster, 1962); acoustic mosquito traps were tested in Cuba (Kahn, Offenhauser, 1949), the "apidictor," an instrument for controlling bee swarming, was developed in England (Woods, 1959), etc. However, in the years that followed there was no further development of acoustical methods and there were virtually no practical applications thereof.

As we analyze the causes of diminished attention to such studies, we must mention three circumstances: in the first place, this period was characterized by excessive enthusiasm for chemical methods of control; in the second place, acoustical methods seemed to be unprofitable at that time, since they required the use of cumbersome and expensive electronic equipment and, in the third place, applied bioacoustics did not yet have the proper theoretical base.

By the end of the 1960's, the situation in this area of research began to change rapidly. The search for new methods of controlling pests that would not pollute the environment and appearance of relatively cheap and compact instruments again raised the question of developing acoustical methods and introducing them into agricultural practice. At the same time, the results of unceasing experimental studies revealed that insects have more complicated and refined acoustical communication systems that was previously assumed. For this reason, it became apparent to most researchers that applied problems can only be solved on the basis of comprehensive analysis of the principles of organization of these systems. A new approach to solving this problem has yielded the first practical results in the last few years, but apparently there is still a large amount of work to be done before acoustical methods will take a worthy place in the arsenal of modern means of regulating the number of economically important insect species.

What are the most promising directions in this area of research? Experience in studying acoustical communication systems shows, first of all, that acoustic signals are used by insects to solve many vital problems. For this reason, having learned to record and analyze these sounds, we can gain some very important information about the species of interest to us. At the very least, it is possible even now to develop devices for detection of pests, determination of their species composition, number, level of activity and distribution in agrocenoses or reservoirs. It is desirable to gather all of this information by

remote control, using diverse sensors, to process it on a computer and use it to forecast or control pests.

Knowledge of the principles of organization of acoustic communication systems of insects arms us with yet another effective tool, the possibility of intervening in the process of transmission of acoustic signals and thereby exert the desired influence on insects or, in other words, controlling their behavior. Devices can be created for this purpose that disrupt in some way or other the normal communication and orientation of insects: those that attract them to traps, scare them away from protected objects, create interference in the communication channel, etc. Nor should one overlook the fact that sound and high-power ultrasound have a depressing effect on insects or lead to their death. Thus, the acoustical resources that we have at the present time enable us to perform three main types of tasks: 1) to obtain and analyze information about pests; 2) to control their behavior; 3) to exert a direct physical effect on them.

Let us consider these questions in somewhat greater detail.

Obtaining Acoustical Information

Acoustical instruments could become irreplaceable tools for determining the latent infestation by insects of all sorts of materials, stock and even plants. Devices that are usually recommended for this purpose include microphones or vibration detectors, amplifiers and recording elements, as well as filters that permit isolation of the useful signal from noise. With such instruments one can pick up both the communicating signals of insects and noise associated with various manifestations of their vital functions.

A device of this type was first developed in Germany to determine infestation of wood by the Xylotrupes bajulus longhorn beetle (Schwarz et al., 1935). Subsequently similar instruments were developed in England, the United States and USSR. In 1953, an acoustical device was proposed for determining latent infestation of grain (Adams et al., 1953). This method was found to be quite effective and gained practical use in several countries (Zakladnoy et al., 1970; Zakladnoy, Snyurina, 1977).

Acoustical methods of detecting soil pests appear to be less promising. However, the results of studies in this direction warrant the belief that such methods could be used, at least in experimental research (mainly under laboratory conditions).

If the sounds emitted by insects are loud enough, one can determine from their intensity not only the location of pests, but their number. True, to obtain satisfactory results, one must adhere to certain conditions, in particular, one should place the pickups at a specific distance from the object, take into consideration the noise level, etc., but theoretically they do not impose appreciable limitations on use of the method. The use of acoustical methods is desirable, not only to keep a record of number of invisible insects, but in cases where other recording methods are ineffective for some reason or other.

Since the sounds of most insects can be well-distinguished by their time and/or frequency parameters, it is theoretically possible to develop methods of

identifying the species of pests. One can use for this purpose both communication signals and sounds that are made when insects move or feed. In the former case, tables or atlases and acoustic instruments can be developed even now that permit identification of Orthoptera and Cicadidae in the field. It is harder to develop equipment to record the sounds of small and concealed species. The efforts made in this direction do not always yield positive results. For example, Wojcik (1968, 1969), who used very complicated equipment, was unable to record the communication signals of several pests of stored products, including Cryptolestes pusillus, which has stridulation organs, and two species of Pyraloidea, Ephestia kuehniella and Cadra cautella. However, this does not mean that these insects do not emit sounds, since precopulation signals have been recorded in another borer species, Corcyra cephalonica (F. coro, verbal communication). Experience in such studies indicates that, in addition to a meticulous choice of acoustical equipment, one must have comprehensive knowledge about the biology of the species under study.

All of these difficulties grow significantly in the study of noncommunicative sounds, which have less marked species-specific features, but progress in the field of analysis of diverse industrial noises may facilitate substantially the solution of this problem.

As noted previously, special acoustical equipment permits not only detection and identification of insects, but obtaining information about various aspects of their vital functions and, first of all, the nature of their activity. The most elementary devices of this type, which include a microphone, amplifier and automatic recorders, are used with success to study the circadian rhythms of insects (see, for example, Medioni, 1964). Analogous devices can be used in the field to gain information about changes in level of pest activity in the course of a day or season. At the present time, there is an opportunity to introduce acoustical methods to monitor insect cultures and, in particular, for automatic regulation of their upkeep conditions. The interest of beekeepers in such control methods is not waning either. Many types of bee activity are associated with certain sounds; for this reason, analysis of the acoustical background in the hive yields important information about the condition of the bee family or changes occurring in it. The data accumulated to date make it possible to design and refine devices similar to the "apidictor" we mentioned before (Woods, 1959; Schauff, 1975; Yes'kov, 1979).

Control of Insect Behavior

Studies in this branch of insect bioacoustics are being pursued in three main directions: development of acoustic attractants, repellents and interference in communication systems (H. Frings, M. Frings, 1965).

Attractants: To attract insects to sound sources, it is expedient to use calling, assembling signals or flight sounds, i.e., signals that have an attractive effect on insects in their natural habitat. By reproducing such sounds or models thereof one can virtually always attract or detect a certain number of specimens of the desired insect species that are situated in the vicinity. For example, Spooner (1968b) proposed the use of simulated response signals of females to trap male Phaneropterinae crickets, and in the above-mentioned experiments with mosquitoes, it was possible to attract some males

to female sounds (Kahn, Offenhauser, 1949). However, these methods must have immeasurable greater efficacy for them to gain practical use. Efforts made at insect attraction on a mass scale to sound have usually failed. In our opinion, the causes of these failures are attributable to the following factors.

In the first place, it is not always possible to use adequate stimuli to attract insects. For example, the sound of female mosquitoes in flight recorded on tape do not attract males if two conditions are not met: the intensity of the sound exceeds 60-70 dB and its source (usually a loudspeaker) is too large (preventing formation of spherical waves). In the second place, many insects have a settled life style and do not migrate beyond a certain range. In the third place, insects are distracted from acoustic traps by natural sound sources, i.e., sounds emitted by specimens of the same species.

To eliminate the first of these obstacles, it is necessary to make a comprehensive study of signals and acoustical environment. And, as we have seen, it is sometimes not enough to know the frequency and time parameters of sounds, and one has to take into consideration their intensity, emitter radiation pattern and other parameters. At the same time, having information about the informative elements of the signal, we should not necessarily strive to reproduce it exactly. As noted previously, time and, occasionally, frequency parameters of signals are markedly dependent on temperature. For this reason, use of tape recordings to attract insects does not appear to be too promising. In our opinion, one must use for this purpose special generators of model signals, which automatically adjust their characteristics with change in temperature. The complexity of such generators (and their cost) depend, of course, on the complexity of the simulated signal. For this reason, in developing the scheme of an instrument, we should provide for reproduction of only the signal elements that determine its attraction to insects.

As for the second of the above-mentioned difficulties, to eliminate it acoustical attractants must be used during periods (which are sometimes quite lengthy) when insects migrate. Mole crickets and many grasshopper species are a good example in this respect. One can increase the number of traps per unit area and the power of emitters to attenuate the distracting influence of natural sound sources. However, it is not always desirable to amplify the sound, since such signals have a repellent effect on some insects. All of these statements can be illustrated on the example of the acoustic traps we developed for mole crickets.

As noted previously, the first experiments on attracting mole crickets of the genus Scapteriscus to sounds were conducted in the United States (Ulagaraj, Walker, 1973, 1975). In these experiments, tapes of model signals were used. On the basis of the data we obtained from studies of the acoustical communication systems of mole crickets (Zhantiyev, Korsunovskaya, 1973), we developed and constructed, together with V. S. Chukanov and D. A. Yusipov, an acoustical system to attract and collect two mole cricket species, Gryllotalpa unispina and G. gryllotalpa. The main element in this system is an electronic unit that generates pulses corresponding to the calling signals of the male mole cricket in time and frequency parameters. After amplification, these pulses are fed to 10-W dynamic loudspeakers installed in cone-shaped plastic traps (1 m in diameter).

A container with fixing liquid is attached to the tapered end of the trap. The trap is buried in the ground to its top edge. As mentioned previously, the pulse repetition frequency in insect sounds is usually a linear function of ambient temperature. For this reason, a thermistor is connected in the generator circuit that automatically regulates pulse repetition frequency in accordance with the results of prior acoustic readings.

The acoustic traps were tested for two seasons in Turkmenia (Baba-Durmaz station). Mole crickets (G. unispina) start to fly with onset of darkness and stop at 0200 hours. The insects flew to the trap mainly from the leeward side and fell into the funnel or descended at some distance from the trap, traveling the remaining distance on the ground. Even under adverse weather conditions (relatively low temperature, wind), up to 50 mole crickets were caught in the trap in 1 h, and 95% were females.

The results of these tests revealed that raising sonic pressure beyond the levels inherent in the natural calling signal had no repellent effect; on the contrary, it increased the attraction of the signal for mole crickets. For this reason, by increasing the power of the emitter one can broaden appreciably the area covered and improve the efficacy of the traps. Analogous data were obtained previously from experiments with two Scapteriscus species (Ulagaraj, Walker, 1973, 1975). Moreover, we established in preliminary experiments that the shape of the pulse envelope does not affect insect reactions. This enabled us to subsequently use square-wave acoustic signals and simplify appreciably the circuitry of the generator.

Repellents: Development of acoustic repellents is one of the most promising but little-elaborated directions of research. Theoretically, such repellents could be used against all insects that have receptors for sonic vibrations or oscillations. In order to elicit negative phototaxis, one can apparently use two types of sounds: biologically important signals (or an imitation thereof), which have a repelling effect under natural conditions, and oscillations at frequencies that elicit discomfort.

The most vivid manifestation of negative phonotaxis is observed in nocturnal Lepidoptera subject to attacks by bats. For this reason, it is not surprising that in the first tests related to development of acoustic repellents ultrasounds simulating the echoranging signals of these animals were used (Belton, Kempster, 1962). The results of field trials revealed that exposure of corn fields to ultrasound (50 ms duration, 50 kHz frequency) lowered by 50% infestation thereof by the beet webworm. Analogous results were later obtained on cabbage and lettuce fields. Use of 20 kHz ultrasounds lowered plant infestation by Trichoplusia ni moths by 66% (Payne, Shorey, 1968). However, trials of this method to control the Heliothis zea moth on corn and cotton did not yield positive results (Agee, Webb, 1969a; Shorey et al., 1972). The authors consider the cause to be that insects perhaps become accustomed to continuously pulsating ultrasound, while large plants prevent propagation thereof. These explanations do not appear quite convincing, since they are in contradiction with the results of the above-mentioned tests.

In general, experience with ultrasound to scare off moths and Pyraloidea has shown that acoustic repellents could become an effective means of control of

many pests of the order Lepidoptera. But to develop such methods, it is necessary to conduct special studies of the life style and behavior of each species. There are grounds to believe that it is expedient to use analogous methods for protection of both crops and stored products.

In time, acoustic repellents may find applications not only in agriculture, but in the control of blood-sucking Diptera. This question has been repeatedly discussed in the scientific literature. Some foreign firms produce devices for personal protection against mosquitoes, of the "mosquito repeller" type, which consist of portable sound generators. However, tests conducted in our country (Rasnitsyn et al., 1974) and abroad (Kutz, 1974) showed them to be entirely ineffective. A search for sonic oscillations that elicit negative phonotaxis in mosquitoes is being pursued in many laboratories. And, although the desired results have not yet been obtained, this does not mean that there are some basic difficulties that prevent development of such repellents.

Eradication of Insects

Eradication of insects with sound is more a technical than a biological problem, so that we shall not deal with it here. Let us merely mention that, according to data obtained to date, ultrasound and sound of sufficiently high power have a depressing effect on insects. For example, there are reports that sounds at frequencies of 0.2-2 kHz inhibit development of Plodia interpunctella moths (Kirkpatrick, Harein, 1965), while powerful ultrasound (0.2-4 W/cm^2) has a devastating effect on Drosophila pupae (Pay et al., 1978).

Apparently sources of sonic and ultrasonic oscillations will be used to destroy insects in stocked or stored materials; however, it is unlikely that they will be used in the field (H. Frings, M. Frings, 1965).

Conclusion

In assessing our knowledge on sonic communication and orientation of insects, it must be noted that the results of intensive experimental research conducted for the last two decades had a deciding influence on forming current conceptions of the principles of organization of their acoustical communication systems.

The greatest progress was made in the study of mechanisms of sound emission, the auditory system and some forms of acoustic behavior. For this reason, we now have a rather complete idea about the neuromuscular system of acoustic organs, acoustical properties of sound-emitting and sound-receiving structures, ultrastructure of auditory receptors, morphofunctional organization of auditory organs and physical characteristics of acoustic signals. Use of combined methods of research made it possible to obtain important data on the functional distinctions of the auditory system in the course of identification and localization of communicative acoustic signals. However, in spite of the efforts of many researchers, we have rather limited information as yet concerning processing of acoustic information in the central parts of the auditory analyzers, and we know virtually nothing about the connections between auditory interneurons and other parts of the central nervous system. As for the neurophysiological mechanisms involved in recognition of conspecific signals, the data available to us enable us to develop only preliminary hypotheses or conceptual models.

In view of these circumstances, we can be sure that most researchers will concentrate in the near future, as they did before, on the problem of recognition and certain other problems of basic importance. But we can also expect further widening of the circle of objects studied and increase in number of comparative bioacoustic studies that will help demonstrate the adaptive distinctions of acoustical communication systems and the patterns of their inception and evolution.

The following main tasks will have to be done in the course of future neurophysiological studies: study of morphofunctional organization of acoustic centers, i.e., neuronal nets implementing the function of diverse acoustic organs of insects; completion of investigation of peripheral and central parts of the auditory analyzers; trace the functional connections between auditory interneurons and associative centers and effector systems. The main results of these studies, which will have been obtained in acute experiments, should then be checked in chronic experiments on mobile insects. Perhaps only such combined studies will enable us to form a definitive idea about the mechanisms of recognition of communicative signals and localization of sound sources.

In the near future, we should expect further development of ethological studies, including not only laboratory experiments to test functional hypotheses and models, but observations in the field, which permit analysis of complex forms of acoustic behavior of insects.

There is still quite a lot to be done with regard to investigation of acoustic signals of insects, particularly their variability, transformation in the course of species formation and adaptive distinctions.

Genetic studies aimed at determination of patterns of inheritance of species-specific distinctions of various elements of acoustical communication systems should yield much interesting and important information.

The results of all these investigations will not only help form a general conception about the principles of organization of insects' acoustical communication systems, but will serve as the basis for developing new and effective methods of controlling the behavior of economically important species.

CONTENTS

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METHOD FOR TELEMETRIC RECORDING OF BLOOD PRESSURE AND RESPIRATION OF FREELY SWIMMING DOLPHINS

Leningrad FIZIOLOGICHESKIY ZHURNAL SSSR IMENI I. M. SECHENOVA in Russian Vol 67, No 11, Nov 81 (manuscript received 4 Dec 78) pp 1744-1748

[Article by V. G. Dargol'ts, Ye. V. Romanenko, Ye. A. Yumatov and V. G. Yanov, Laboratory of Morphology and Ecology of Higher Vertebrates (headed by V. Ye. Sokolov); Laboratory of Bioacoustics (headed by Ye. V. Romanenko), Institute of Evolutionary Morphology and Ecology of Animals imeni A. N. Severtsov, USSR Academy of Sciences; Department of Normal Physiology (headed by K. V. Sudakov), First Moscow Medical Institute imeni I. M. Sechenov, Moscow]

[Text] At the present time, various techniques have been developed to study cardiovascular and respiratory functions of terrestrial animals, which permit recording arterial pressure, the electrocardiogram, volumetric and linear blood flow, pneumogram, etc., in different states of an organism, including unrestrained animals [1, 2].

At the same time, there is also a need for such studies on aquatic animals, for example, dolphins, when their behavior is unrestricted. In particular, it is interesting to make a comparative analysis of cardiovascular and respiratory functions during emotional reactions of animals situated in different environments. A need also arose to examine regulation of arterial pressure and respiration in delphinids in connection with problems of hydrodynamics and bioacoustics.

However, there are a number of technical difficulties involved in recording these functions on freely swimming animals. It is necessary to develop a sealed telemetry device for this purpose, with its own power pack that would pick up useful information and transmit it from the aquatic environment to receiving equipment. We describe here an instrument that meets these requirements.

The functional flowchart of a radiotelemetry instrument, which we designed and constructed to measure blood pressure, as well as air pressure in the respiratory system of the bottlenosed dolphin, swimming freely in a restricted body of water (tank, marine pen), is illustrated in Figure 1.

An Elema-Schonander (EMT-34) type sensor *1* served as the device that picked up pressure directly, and its working chamber was connected to a blood vessel

or tested part of the dolphin's respiratory system by means of a catheter 1.5-2 mm in diameter. To measure blood pressure, the working chamber of the sensor and catheter were first filled with saline, which transmitted blood pressure to the sensitive element of the sensor. Output voltage which changes slowly is the information signal, whose amplitude is proportional to excess pressure, in relation to atmospheric, from the symmetrical output of the sensor, and it was fed to converter *2*. In the converter, the clock pulses coming from the clock pulse generator with a repetition frequency F_n = 2 kHz *3*, are submitted to pulse-amplitude modulation by the information signal. The same pulses divided into four frequencies, *4*, *5*, served as the calibration signal. We determined the necessary correlation between level of calibration signal and pulse-amplitude modulated information signal by means of two dividers, R_1-R_3 and R_2-R_3.

The overall signal then passed from adder *7* to the generator with frequency modulator *8*, where it modulated the carrier frequency which had a frequency of 31 kHz in the "silent" mode. After the amplifier *9*, the signal was emitted into salt water. We used narrow-band frequency modulation with a modulation index of m = 0.4.

Transmission of information about pressure coded in this manner was effected via an underwater radio channel.

The generated power of the transmitter constituted 50 mW on a resistance of 7 Ω, which provided for a range of certain reception of up to 8-10 m. This range makes it possible to receive a signal distinctly over the entire volume of the pen or closed tank. The construction of the transmitting and receiving antennas is described in [3].

And now a few words about the choice of coding method. In view of the fact that a signal with slowly changing frequency has a rather small amplitude with actual values of blood pressure and air pressure in the dolphin's respiratory system, it was found expedient to use a subcarrier frequency (in the form of clock pulses), amplitude modulated by the useful signal, and subsequently work with this subcarrier frequency signal. The concurrent presence of a clock signal makes it possible to form a calibration signal required for absolute readings that is a multiple thereof in frequency.

Reception of radiotransmitter signals is effected by means of a specially developed receiver of frequency-modulated signals, which consisted of two functional units [block units]: the unit of selective amplifiers *10* (with central tuning frequency f = 31 kHz and band of 2 Δf = 8 kHz) and demodulation unit *11*. The carrier frequency was demodulated and overall signal, which consisted of the pulse-amplitude modulated information signal at a frequency of 2 kHz containing information about pressure and calibration signal of 500 Hz was isolated in the receiver. This overall signal after the necessary division *12* was recorded on one of the channels of an Elektronika-100 type tape recorder *13*, while the explanatory text was recorded on another channel from microphone *14*.

In the course of processing the recorded results, the overall signal was reproduced on the same tape recorder and fed to two filters: band filter with central frequency of 2 kHz and band of 2 Δf = 650 Hz *15* and a filter for lower frequencies with cut-off frequency of 1020 Hz *16*. The band filter served to isolate the intermediate frequency of 2 kHz with pulse-amplitude modulated information signal, while the lower frequency filter served to isolate the calibration signal.

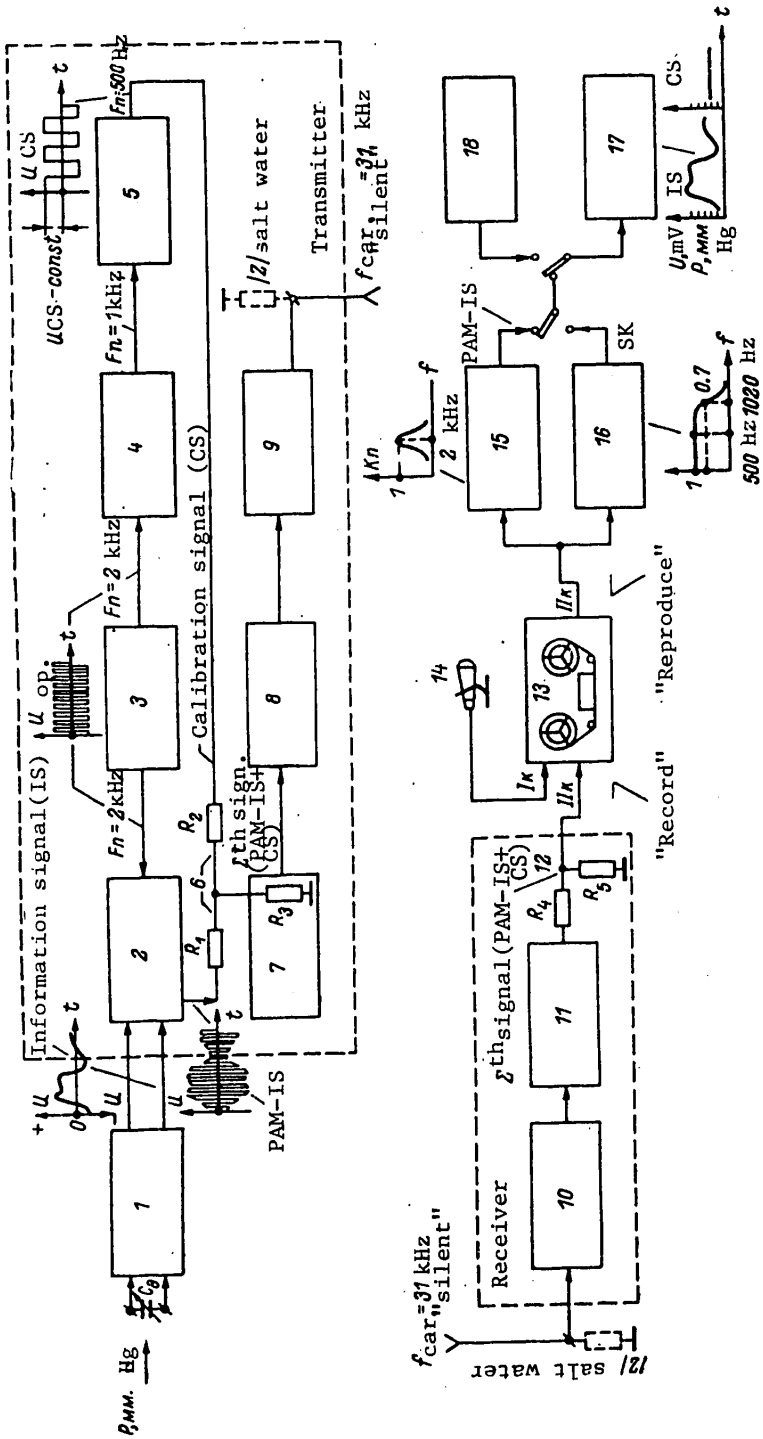

Figure 1. Functional flowchart

1) Elema-Schonander (EMT-34) pressure sensor
2) converter
3) clock pulse generator
4,5) frequency dividers
6) information and calibration signal dividers
7) adder
8) generator with frequency modulator
9) power amplifier
10) selective amplifier unit
11) demodulation unit
12) divider
13) Elektronika-100 tape recorder
14) microphone
15) band filter
16) lower frequency filter
17) Bruel and Kjxder (2305A) recorder
18) GZ-102A calibration generator

The coefficients of transmission of the band filter at a frequency of 2 kHz and lower frequency filter at a frequency of 500 Hz equaled 1. Then, the information and calibration signals divided by frequency were recorded alternately on paper of a Bruel and Kjxder 2305A recorder. The scales of recorder levels were calibrated at the beginning and end of each tracing with the signal from an external type GZ-102 generator *18*.

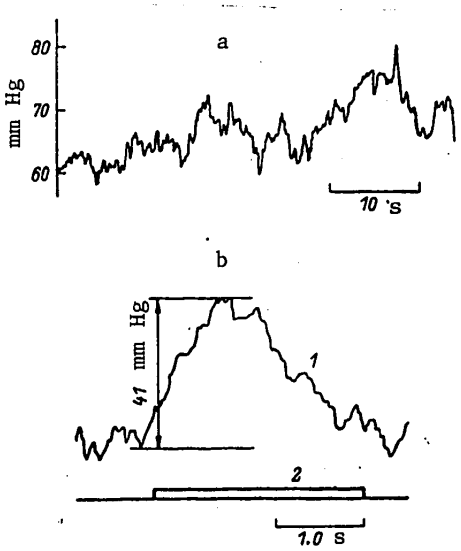

Figure 2. Samples of pressure tracings

a) blood pressure in vessels of tail fin
b) air pressure in main nasal passage during emission of echoranging series
1) pressure curve
2) echoranging time

If one knows the pressure to which corresponded the constant amplitude of the calibration signal and graduation characteristics of the pressure sensor, one could estimate absolute pressure in blood vessels or airway system of the dolphin at each point in time.

The transmitting equipment *1* together with pressure sensor *2* were attached to the dorsal fin of the dolphin. A flexible catheter, 1.5-2 mm in diameter, filled with saline and heparin (to prevent blood clotting) was introduced into one of the arteries of the dorsal or tail fin and connected to the pressure sensor. Before taking each reading the catheter was flushed with the same solution. Access to the artery was provided by cutting off a 2-3 cm end of the fin. To measure air pressure in the respiratory tract of the dolphin, the air-filled catheter was introduced into the choanæ or blowhole above them and attached with a suction cup near the entrance into the blowhole.

Figure 2a is a sample of a tracing of blood pressure in vessels of the tail. Blood pressure in vessels of the tail fin of a free-swimming dolphin is of the order of 60-80 mm Hg. It should be noted that the dolphin did not submerge to any depth during this time. Blood pressure in vessels of the dorsal fin is 1.5-2 times higher, and this is apparently related to the closeness of dorsal fin vessels to great arteries, their larger diameters, as compared to vessels of the tail. In addition, it was possible to introduce the catheter deeper into vessels of the dorsal fin than into the smaller vessels of the tail.

Air pressure was recorded in the region of the main nasal meatus (blowhole), between the external sphincter and muscle plug shutting entry into the choanae (Figure 2b). Pressure curve *1* is correlated to echoranging time *2*. Typically, the echoranging process is always associated by approximately 30-50 mm Hg increase in pressure in the blowhole, whereas pressure in the choana does not change.

It should be noted that we set the pressure sensor to zero at the start of each experiment. For this purpose, we equalized pressure in the working chamber of the sensor with atmospheric pressure. The sensor was then adjusted for a minimal output signal in the absence of excess pressure in the catheter. The remaining dysbalance signal at the output of the sensor was recorded on tape, and its value served as the zero reference point.

This technique permits satisfactory reading of both blood pressure in blood vessels and air pressure in the dolphin's respiratory tract when the animal swims on the surface without submerging. Artefacts were found in the course of recording blood pressure, which were related to submersion of the animals, and with measurement of pressure in the caudal artery with movement of the flukes while swimming.

With submersion, the distance between the sensor and reading site has an effect. This occurs because of the flexibility of the walls of the long catheter (1.0-1.5 m), which transmit water pressure and distort the true pressure of both blood and air in the respiratory tract. To rule out such artefacts, we placed the sensor as close as possible to the measurement site on the dorsal fin, thus also reducing the length of the catheter to a minimum.

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KOVATS INDEXES USED TO IDENTIFY SEX PHEROMONES

Tashkent KHIMIYA PRIRODNYKH SOYEDINENIY in Russian No 4, Jul-Aug 81 (manuscript received 19 Jan 81) pp 501-505

[Article by S. F. Nedopekina, B. G. Kovalev and A. N. Kost†, All-Union Scientific Research Institute of Biological Methods of Plant Protection, Kishinev; Moscow "Order of Lenin," "Order of the October Revolution" and "Order of Red Banner of Labor" State University imeni M. V. Lomonosov]

[Text] In view of the development of new methods of protecting plants, which are safe to the environment, there is special interest in substances of natural origin--sex pheromones of insects--use of which is considered quite promising [1].

Isolation and identification of the structure of natural pheromones involve a number of difficulties, due chiefly to the small amounts of this substance contained in insect glands (nanogram range). Hence the need to use highly sensitive physical and physicochemical methods, as well as combinations thereof with chemical identification.

The pheromones of Lepidoptera identified to date consist mainly of unsaturated aliphatic alcohols, their acetates, aldehydes, esters and epoxides containing 10-18 atoms of carbon [2].

Identification of a natural pheromone involves determination of the length of the molecule's carbon chain, quantity, position and configuration of dual bonds, as well as the nature of other functional groups it contains.

Relative gaso-chromatographic retention level is often used to describe functional groups of analyzed compounds [3]. Kovats [4] proposed the use of the difference between indexes of compound retention in two phases of different polarity ΔI_{12} as a characteristic parameter:

$$\Delta I_{12} = I_1 - I_2, \qquad (1)$$

where I_1 and I_2 are the retention index on stationary liquid phases 1 and 2, respectively. ΔI_{12} is the characteristic of the functional group; it depends on the nature of the stationary phase and depends little on column temperature. Experimental determination of the value of ΔI_{12} makes it possible to relate the analyzed compound to a specific class, provided the values of ΔI_{12} have been tabulated for a large number of known substances.

The retention index of a compound is the sum of the retention index of the carbon shell and increments corresponding to functional groups. This makes it possible to determine the retention index of the carbon shell, if the contribution of the functional group and length of the carbon chain are known, bearing in mind that the contribution of the methylene group is 100 units.

Our objective here was to construct tables of retention indexes for unsaturated aliphatic alcohols, their acetates and some epoxides. The practical usefulness of the tabulated data is demonstrated on the example of identification of natural pheromones of female cabbage (Mamestra brassicae) and tomato (Mamestra oleracia) moths.

We used n-alkanes (C_nH_{2n+2}, where n = 12-17, 19, 20, 23, 24) as standards for determination of I. We calculated I using the following equation [5]:

$$I_x = 100 \cdot n_1 + 100 (n_2 - n_1) \frac{\lg l_x - \lg l_{n_1}}{\lg l_{n_2} - \lg l_{n_1}}, \qquad (2)$$

where n_1 and n_2 are the number of atoms of carbon in the corresponding n-alkanes, l_{n_1}, l_{n_2} and l_x are distances on the chromatogram from introduction of sample to height of corresponding peak (in millimeters), and

$$l_{n_2} > l_x > l_{n_1}.$$

The increments of functional groups for each type of phase were calculated as follows:

$$\Delta I_1 = I^{\text{APL}} - 100 \cdot n,$$

$$\Delta I_2 = I^{xe-60} - 100 \cdot n, \qquad (3)$$

where I^{APL}, I^{xe-60} is the retention index of the compound at the corresponding phase;
n is the legnth of the carbon chain.

The difference between retention indexes of the compound on polar and nonpolar phases was determined using the formula:

$$\Delta I_{12} = I^{xe-60} - I^{\text{APL}}. \qquad (4)$$

All of the obtained values are listed in Tables 1-4.

The tables show that use of the difference between retention indexes on polar and nonpolar phases (ΔI_{12}) makes it possible to identify rather accurately ethylene alcohols (ΔI_{12} = 371-429 units), their acetates (ΔI_{12} = 286-345 units) and saturated epoxides (ΔI_{12} = 264-276 units). However, we see that there is some overlapping of values of ΔI_{12} (Table 4) for ethylene acetates (286-345 units) and saturated alcohols (337-364 units), as well as saturated acetates (260-299 units) and epoxides (264-276 units). In this case, for exact identification one

should use the increments of functional groups for each type of phase (ΔI_1, ΔI_2, Table 4), which differ substantially.

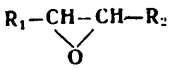
Table 1. Retention indexes for ethylene acetates with the general formula $R\text{-}CH = CH(CH_2)_n OAc$ (cis) and some saturated acetates

Compound	T, °C	I^{APL}	ΔI_1	I^{Xe-60}	ΔI_2	ΔI_{12}
$C_7H_{15}CH=CH-CH_2OAc$	130	1338	338	1624	624	286
$C_6H_{13}CH=CH(CH_2)_2OAc$		1330	330	1616	616	286
$C_5H_{11}CH=CH(CH_2)_3OAc$		1314	314	1626	626	312
$C_3H_7CH=CH(CH_2)_5OAc$		1337	337	1644	644	307
$C_2H_5CH=CH(CH_2)_6OAc$		1346	346	1654	654	308
$C_{10}H_{21}OAc$		1359	359	1626	626	267
$C_7H_{15}CH=CH(CH_2)_3OAc$	170	1520	320	1831	631	311
$C_5H_{11}CH=CH(CH_2)_5OAc$		1527	327	1844	644	317
$C_4H_9CH=CH(CH_2)_6OAc$		1533	333	1840	640	307
$C_2H_5CH=CH(CH_2)_8OAc$		1540	340	1866	666	326
$C_{12}H_{25}OAc$		1562	362	1822	622	260
$C_9H_{19}CH=CH(CH_2)_3OAc$	190	1719	319	2046	646	327
$C_4H_9CH=CH(CH_2)_8OAc$		1734	334	2073	673	339
$C_3H_7CH=CH(CH_2)_9OAc$		1734	334	2074	674	337
$C_2H_5CH=CH(CH_2)_{10}OAc$		1743	343	2088	688	345
$C_{11}H_{23}OAc$		1757	357	2052	652	295
$C_6H_{13}CH=CH(CH_2)_8OAc$	210	1925	325	2267	667	342
$C_5H_{11}CH=CH(CH_2)_9OAc$		1929	329	2272	672	343
$C_4H_9CH=CH(CH_2)_{10}OAc$		1936	326	2278	678	342
$C_3H_7CH=CH(CH_2)_{11}OAc$		1934	334	2269	669	335
$C_{16}H_{33}OAc$		1960	360	2259	659	299

Table 2. Retention indexes of ethylene alcohols with general formula $R\text{-}CH = CH(CH_2)_n OH$ (cis) and some saturated alcohols

Compound	T°, C	I^{APL}	ΔI_1	I^{Xe-60}	ΔI_2	ΔI_{12}
$C_7H_{15}CH=CH-CH_2OH$	130	1221	221	1608	608	387
$C_6H_{13}CH=CH(CH_2)_2OH$		1225	225	1596	596	371
$C_5H_{11}CH=CH(CH_2)_3OH$		1213	213	1614	614	401
$C_{10}H_{21}OH$		1253	253	1590	590	337
$C_6H_{13}CH=CH(CH_2)_4OH$	170	1419	219	1821	621	402
$C_5H_{11}CH=CH(CH_2)_5OH$		1419	219	1820	620	401
$CH_3CH=CH(CH_2)_9OH$		1450	250	1861	661	411
$C_{12}H_{25}OH$		1453	253	1804	604	351
$C_5H_{11}CH=CH(CH_2)_7OH$	190	1626	226	2035	635	409
$C_4H_9CH=CH(CH_2)_8OH$		1629	229	2048	648	419
$CH_3CH=CH(CH_2)_{11}OH$		1657	257	2086	686	429
$C_{14}H_{29}OH$		1658	258	2022	622	364
$C_4H_9CH=CH(CH_2)_{10}OH$	210	1833	233	2253	653	420
$C_{16}H_{33}OH$		1862	262	2226	626	364

Table 3. Retention indexes of epoxides with the general formula



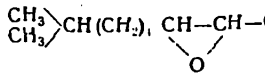
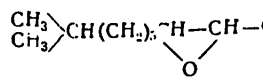
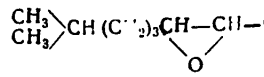
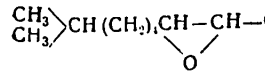
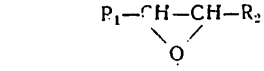
Compound	I_{190}^{APL}	ΔI_1	I_{190}^{xe-60}	ΔI_2	ΔI_{12}
	1795	95	2060	360	265
	1998	98	2272	372	274
	1896	96	2160	360	264
	1990	90	2266	366	276

Table 4. Increments of retention indexes for functional groups

Compound	ΔI_1	ΔI_2	ΔI_{12}
$R-CH=CH(CH_2)_n OH$	213—257	596—686	371—429
$R-CH=CH(CH_2)_n OAc$	314—346	616—688	286—345
$C_n H_{2n+1}OH$	253—262	590—626	337—364
$C_n H_{2n+1}OAc$	357—362	622—659	260—299
	90—93	360—372	264—276

Within a specific class of compounds, the value of the retention index (I) at a given phase permits determination of the length of the carbon chain provided we know the contribution of the functional group at this phase ($\Delta I_1, \Delta I_2$):

$$n = \frac{I_1 - \Delta I_1}{100} = \frac{I_2 - \Delta I_2}{100}. \quad (5)$$

For all of the tested alcohols and acetates, the value of I is an overall one, including the contribution of the alcohol or acetate group and unsaturated bond. If the retention indexes of saturated compounds are known, one can assess the contribution of the multiple bond.

The value of ΔI_{12} is determined primarily by dipole-dipole interaction between the dissolved substance and stationary phase. With increase in polarity of the molecule, there is increase in value of ΔI_{12}, and this is evident on the example of the compounds studied:

$$\Delta I_{12}(C_nH_{2n+1}OH) > \Delta I_{12}(C_nH_{2n+1}OAc) > \Delta I_{12}\ (R_1-\underset{\diagdown\ \diagup}{CH-CH}-R_2),\ \text{as well as}$$
$$\text{O}$$

$$\Delta I_{12}(R-CH=CH(CH_2)_nOH) > \Delta I_{12}(C_nH_{2n+1}OH) \quad \text{and}$$
$$\Delta I_{12}(R-CH=CH(CH_2)_nOAc) > \Delta I_{12}(C_nH_{2n+1}OAc).$$

The existing scatter of values of I and ΔI for each class of compounds is attributable to the influence of the length of the molecular chain and position of multiple bond, a change in which alters the mutual influence of functional groups, which affects general polarity of the molecule.

The obtained retention indexes were used to identify the sex pheromones of female cabbage and tomato moths.

We determined the retention index of the chromatographic peaks on two columns of different polarity, corresponding to the length of the chain and functionality of pheromones to determine these parameters.

Female extract consists of a mixture of substances. In order to refer a specific peak on the chromatogram to a pheromone, preparative selection of 1-minute extract fractions was made, followed by electroantennographic testing, as described in [6]. We then identified peaks contained in fractions, on which male antennae showed maximum responses. It should be noted that, in view of the small amount of active substance contained in insect glands, the pheromone peak is not traced on the chromatogram, whereas the antennae respond to the corresponding fraction. In this case, it is quite helpful to use Kovats indexes that can be calculated from the time of appearance of the fraction that yields the maximum response of male antennae.

The pheromone of female cabbage moths consists of one main component I^{I} with retention indexes $I_1^I = 1936$, $I_2^I = 2278$ and $\Delta I_{12}^I = 342$. The pheromone of the tomato moth has two components (I^{II}, I^{III}), and the retention indexes are $I_1^{II} = 1833$, $I_2^{II} = 2253$, $\Delta I_{12}^{II} = 420$, $I_1^{III} = 1936$, $I_2^{III} = 2278$, $\Delta I_{12}^{III} = 342$.

If we compare the values of ΔI_{12} of natural pheromones to the tabulated data (Tables 1, 2, 4) it is easy to see that the I^{I}, I^{III} ($\Delta I_{12} = 342$ units) peaks fall into the range of ethylene acetates, while the I^{II} peak is in the range of ethylene alcohols ($\Delta I_{12} = 420$ units). The coincidence of retention indexes on nonpolar and polar phases of natural pheromones with hexadecenol and hexadecenyl actetate models leads us to the conclusion that the length of the carbon chain of the compounds to be identified is 16. In the general case, one should use formula (5) to determine chain length.

Experimental Section

The retention indexes were determined on a Khrom-42 chromatograph with flame-ionization detector. The glass columns are 2.5×3 mm in size. The carrier gas is extra pure nitrogen. We used N-AW-HMDS 60/80-mesh chromaton as the solid carrier. Apiezon L (8%) served as the nonpolar phase and XE-60 nitrile silicone rubber (15%) as the polar phase.

Conclusions

Determination was made of retention indexes of a series of unsaturated alcohols, acetates and saturated epoxides on two columns of different polarity. The obtained tabulated data were used to determine chain length and functionality of pheromones of two moth species.

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SEISMOSENSORY SYSTEM AND CLASSIFICATION OF COTTIDAE FISH (MYOXOCEPHALINAE, ARTEDIELLINAE)

Leningrad SEYSMOSENSORNAYA SISTEMA I KLASSIFIKATSIYA KERCHAKOVYKH RYB (COTTIDAE: MYOXOCEPHALINAE, ARTEDIELLINAE) in Russian 1979 (signed to press 28 Aug 79) pp 2-7, 207-208

[Annotation, introduction and table of contents from book "Seismosensory System and Classification of Cottidae Fish (Myoxocephalinae, Artediellinae)" by Aleksey Vadimovich Neyelov, approved by the Zoological Institute of the USSR Academy of Sciences, Izdatel'stvo "Nauka", 1100 copies, 208 pages]

[Text] This monograph deals with a comparative morphology of the seismosensory system of 54 species and subspecies of Cottidae. Original studies are preceded by analysis of the worldwide literature on morphology of the seismosensory system of Anamnia vertebrates, different aspects of function, nature of variability and use in systematics and phylogenesis. A classification of both subfamilies studied is validated on the basis of the structure of various systems of organs. Characteristics and identification of various taxons through subspecies levels are submitted. There is discussion of the nature and patterns of evolutionary transformations of different elements of the seismosensory system and phylogenetic relations and evolution of Cottidae. References 642, illustrations 85.

Introduction

The Cottidae family is the largest group of fish, with regard to number of species, in the ichthyofauna of the USSR and adjacent waters. Expressly the Cottidae constitute the most substantial element of the fauna of our northern and far eastern seas. Thus, Andriyashev (1939b) reports 297 fish species in the Bering Sea, 65 of which are Cottidae, i.e., over one-fifth (21.9%) of its entire ichthyofauna.

Cottidae are represented by 10 species in the Kara and Chukotsk seas of the 56 and 44 species of fish, respectively, known in these seas (Andriyashev, 1954). Schmidt (1950) cites about 50 species of Cottidae for the Sea of Okhotsk, or almost one-fifth of the entire fish fauna. Wilimovsky (1964) stresses in particular that 45 out of the 140 species of fish in coastal regions of the Aleutian Archipelago, or almost one-third, consist of bullheads of the Cottidae family, and no other families can compete with them in this regard. Cottidae play an exceptionally large part in the fauna of Lake Baykal; all 26 bullhead species[1] are endemic to this lake (Taliyev, 1955).

As yet, very little has been done with regard to working out the morphological bases of the system of the Cottidae family and particularly with respect to

evolutionary relations between the taxons it includes. In this respect, the Baykal bullheads were the "luckiest," since comprehensive studies thereof resulted in the excellent monograph by Taliyev (1955). In this work, the author devoted several pages to evolution of bullheads of the Cottidae family in connection with the origin and formation of endemic bullhead fauna of Lake Baykal. Current conceptions of the scope and relations within Cottidae and families close to it are based on the rather concise, but morphologically validated work of Taranets (1941), "Classification and Origin of Bullheads of the Cottidae Family."

A large group of father-lasher bullheads, which Taranets (1941) placed in the Myoxocephalinae subfamily numbering 14 genera with 48 species, according to Taranets, occupies the central position in this family. Schmidt (1950), Taliyev (1955) and Bolin (1947b) stressed the leading role of Myoxocephalinae among the Cottidae. Not only are the species of this subfamily numerous, but they are extremely diverse. Father-lasher bullheads are among the most common elements of the benthic ichthyofauna of all our northern and far eastern seas. Moreover, they are quite numerous within the range of their habitat, inhabiting seas from the littoral zone to depths of about 2000 m, i.e., they are also among the deepest water fish in the Cottidae family. Some species form concentrations of commercial magnitude. Thus, in 1970, 2653 tons of bullheads were caught in the Northeast Atlantic (Statistical Information on USSR Fishing in the Northeast Atlantic ..., 1971b), and 1283 tons were caught in the Baltic Sea (Statistical Information ..., 1971a).

The Cottidae species studied are very important to work on zoogeography and origin of ichthyofauna of different bodies of water.

The foregoing explains, to some extent, the reason for the increased interest of ichthyologists all over the world in bullheads of this group and Cottidae in general. Hence it is understandable that this book, which has some prior history, was the logical development of the interest of Russian ichthyologists in this group of fish.

Originally, the work was planned as a study on the "Fauna of the USSR," where attention would have been focused on osteological and external morphological distinctions of structure, which are generally used extensively and constantly in studies of fish. However, in the course of this work, I consistently encountered instances where the status of the species was quite vague and the range diffuse, i.e., it was impossible to offer a clearcut description of the species and, quite often, of the genus as well. It was necessary to find some morphological criteria, which had not been discovered before (if they existed at all) that would permit demonstration of rather distinct species-specific differences in the group under study.

As a result of comprehensive studies of the morphology of different systems, including osteology and external morphology of many species of the Myoxocephalinae s. l. subspecies, it was found that the species and entire groups of species are quite distinguishable, primarily according to quantity, structure and, first of all, topography of integumental canals and pores of the seismosensory system of the head and body. Expressly the structural distinctions of the seismosensory system or, as it is usually inaccurately, but commonly called the"lateral line organs," enabled us to comprehend, to a certain degree of course, the systematic correlations in the Myoxocephalinae s.l. subfamily. Having some degree of species specificity, the general structural plan of the seismosensory system

turned out to be profoundly different in the two tribes with the most species--Myoxocephalini and Artediellini, subfamily Myoxocephalinae (in the scope adopted by Taranets, 1941). Structural differences in the seismosensory system of hooked-horn bullheads (Artediellini of Taranets) and all other representatives of this subfamily made it possible to validate the independence of the hook-horns in a separate subfamily (Artediellinae), along with the use of other morphological structural distinctions. Its species-specificity made it possible to clearly distinguish within these two subfamilies lower taxons through species. This, in turn, made it possible to make broader use of the distinctions of external morphology, which it had been sometimes impossible to detect before exact differentiation between species.

In the course of our work, we ecountered a number of methodological difficulties. The main one was the absence of developed terminology to designate the numerous canals and pores of the seismosensory system of the fish head. Usually, no attention was paid to such structural distinctions of the peripheral branches of the seismosensory system when it was studied, since it was essentially the route and nature of the canals that were studied. Apparently, this is why insufficient details were provided about the peripheral branches of the seismosensory system and it is the reason for absence of conventional terminology for them (Makushok, 1958, 1961c; Jakubowski, 1965; Cowan, 1970, 1971). It was necessary to not only find a convenient method to study the system proper and stock material, but primarily to systematize the large quantity of pores and cutaneous canals which appeared, at first glance, to be quite disorderly in arrangement. After this, it was necessary to develop a system of designations, with which it would be convenient, to some extent, of course, to work in describing the structural distinctions of the fish sense organs under study. Since this is, to some extent, the first attempt at a comprehensive description of the morphology of the peripheral branches of the seismosensory system, this author realizes that it is far from perfect, and would be very appreciative of all critical comments and additions that would improve it.

Comprehensive studies of the topography of the seismosensory system as applied to systematics was largely instrumental in developing the conceptions submitted in this book concerning the validity of different taxons and their systematic rank, which led to development of conceptions concerning the evolutionary relations of the fish species studied.

The large number of species and their considerable morphological variety made it possible to trace on vast (in the sense of species) and moreover related material the following: in the first place, the diversity of structure, primarily the topography of peripheral branches (canals and pores) of the seismosensory system of closely related forms with the same general structural plan thereof; in the second place, the significant differences in structure of central parts of the seismosensory system (morphology of canals) and communication with the environment and, in the third place, which is the main point, this diversity enabled us to demonstrate and trace the direction and sequence of evolutionary changes in structure of the seismosensory system of species of the same genus, different genera and similar genera. As a result, we found instances of morphological parallelism, where species formed homologous series in the meaning of Vavilov (1967) and ecological parallels in the meaning of Berg (1935). As a result, all this made it possible to propose, of course with the use of the entire set of studied morphological structural distinctions, a system of subfamilies, their position

among Cottidae and to submit a scheme of probable phylogenetic relations between taxons in this group. It is expressly on the basis of comprehensive morphological analysis of structural distinctions of the seismosensory system of all representatives of the Myoxocephalinae and Artediellinae subfamilies that I demonstrated (Neyelov, 1967a, 1967b, 1971a, 1971b, 1973a, 1976, 1977) that simplification of structure of peripheral branches--oligomerization according to Dogel[1]--should be considered one of the main directions of evolutionary transformations of this system of sense organs in bullheads and sculpins.

In working out the system of subfamilies, we also used some of the osteological distinctions of structure of the skull and axial skeleton (mainly for substantiation and characterization of subfamilies). For characteristics of various taxons, extensive use was made of external morphological structural features, which are generally used in systematizing and identifying Cottidae (along with new or previously insufficiently used morphological structures). This enables us to make use of the abundant factual material already accumulated from all previous studies and to include in the identifications and determination tables external morphological structures that can be readily seen with the most cursory examination of fish and could always be compared to already existing descriptions.

Such synthesis of morphological structures which were used for the first time and external morphological distinctions used previously was instrumental in more accurate utilization of these features and made it possible to describe more fully a given taxon within the form of a brief diagnosis. It is expressly because of these considerations that I resisted the temptation of constructing identification tables and offering taxon diagnoses solely on the basis of the distinctions of the seismosensory system, although this could have been done (as, for example, was done by Illick, 1956 and Nelson, 1972).

In view of the foregoing, it was necessary to alter the initial direction of research, devoting more attention to morphology than fauna proper.

This book consists of an introduction and five chapters. The first chapter deals with the history of research on the seismosensory system, general conception of its structure, function and use of its morphological distinctions in systematics and phylogenesis.[2] The second chapter is concerned with morphology of the seismosensory system of cottoid bullheads and sculpins and contains the following: information about the volume of material studied, terminology for peripheral branches (canals and pores) of the seismosensory system which was developed and is proposed for Cottidae, general morphological description of this system in both subfamilies, description of genera and species with reference to seismosensory system, and it is illustrated with original drawings. The third chapter contains a morphological validation of the independence of Myoxocephalinae and Artediellinae subfamilies and lower ranking taxons. Chapter 4 has information about the scope of the subfamilies under study and changes in the system of these fish, as compared to the classification of Taranets. This chapter includes identification tables for all taxons through the subspecies, characteristics of subfamilies, tribes and genera, and diagnoses for all lower taxons. The diagnoses are listed in the identification tables in the form of an expanded thesis or antithesis. There too is brief information about the distribution and habitat depth. After the description of each genus, its scope is indicated--list of species and the main synonyms. The synonyms are provided in full for taxons

from the genus level up. Since the complete validated name, with its author, is given for all of the species studied, the author's name is omitted in the rest of the book where only their Latin names are given. The Latin name of all other mentioned species is given along with its author.

In view of the fact that the International Commission for Zoological Nomenclature adopted a decision to consider 1814 the year of publication of "Zoographia Rosso-Asiatica" by Pallas (Vol 3, Fishes) (Svetovidov, 1976), unlike the previously used year of 1811, this change is taken into consideration in indicating the year of description of the relevant Pallasian species.

The book concludes with Chapter 5, in which there is discussion of direction of specialization of the seismosensory system, its evolution as a system of sense organs that implement direct contact between the organism and habitat, questions of evolution of the systematic groups studied and offers a scheme of phylogenetic relations within the Myoxocephalinae and Artediellinae subfamilies.

This work constitutes an attempt at systematization of morphological details of structure of the seismosensory system and to use this system of sense organs for the purpose of classification and identification of taxons on the subspecies-subfamily rank.

This work was done in the laboratory of ichthyology of the Zoological Institute, USSR Academy of Sciences. I wish to express my profound appreciation to the management of this institute and laboratory for granting me the opportunity to work in that laboratory and make use of its rich fish collection. I wish to express my sincere appreciation and profound gratitude to A. P. Andriyashev, corresponding member of the USSR Academy of Sciences, for his considerate and attentive attitude throughout my work on the monograph and for taking on the job of editing the manuscript. The advice and constant aid of Anatoliy Petrovich were largely instrumental in following the adopted direction of research. I am also profoundly grateful to the never to be forgotten G. U. Lindberg for his constant interest in my work, valuable advice and availability for consultation whenever necessary, as well as the opportunity to use the abundant bullhead catches of the Kuril-Sakhalin expedition. I am sincerely grateful to V. M. Makushok, who unintentionally was the inspiration for the chosen direction of investigation for his advice in making the morphological drawings. To all of the laboratory staff, my friends and coworkers and particularly senior laboratory technicians A. A. Korovkina, M. S. Morozova and V. P. Prirodina I am profoundly grateful, and I thank all of them for their constant assistance in everyday work and support, without which the book would hardly have been completed. I offer my sincere gratitude to the staff of the Zoological Institute library, and particularly to the bright memory of Ivan Georgiyevich Musatov, for their constant aid in bibliographic work. Without this library and its sharp staff our work would have been simply inconceivable. My sincere gratitude goes to all comrades and friends who were involved in some way or other in this work. I am profoundly grateful to artists M. M. Zharenkov and N. D. Ogloblina for rendering in India ink the author's original morphological drawings and diagrams sketched in pencil. I take this opportunity to express my appreciation to V. V. Fedorov,[3] L. S. Kodolov, V. P. Shuntov on the staff of TINRO [Pacific Ocean Scientific Research Institute of Fisheries and Oceanography], O. G. Kusakin, V. M. Matyushin and V. I. Pinchuk on the staff of the Soil Biology Institute of DVNTs [Far East Research Center?] of the Siberian Department of the USSR Academy of Sciences, as well as all other comrades

for placing at my disposal the Cottidae caught in the basin of the Pacific Ocean. I am deeply grateful to doctors D. M. Cohen (U. S. N. M.) and J. Nielsen (Univ. Zool. Museum, Copenhagen) for granting the opportunity of examining bullhead specimens lacking in our collections, which they were kind enough to send me. Finally, I wish to thank with all my heart my Polish colleague, Doctor M. I. Jakubowski, who was kind enough, during his visit to the Zoological Institute, to help me learn to use the original techniques he developed for examining organs of the seismosensory system.

FOOTNOTES

1. The Russian name for fish of the Cottidae family--"kerchakovyye" or "rogatkovyye" [father-lashers or horned fish] (Rass, Lindberg, 1971) does not always apply well to all species, so that in addition to these names, this author has also used the name, "bullheads," which is old and has been in wide use for a long time, and currently used to refer only to the Gobiidae family; the name, "sculpins," is used for fresh-water species of this family.

2. To his profound regret, the author was unable to make use here of the excellent monograph by Disler, published in 1977, dealing with morphology and development of seismosensory system organs of Euselachiae, or for reasons beyond his control to make use of the interesting works of Cowan (1970, 1971, 1972a, 1972b, 1973) and Kartavtsev (1975) dealing with species of the genus Myoxocephalus in the discussion of his own findings (Chapter 5).

3. Presently a scientist in the laboratory of ichthyology of the Zoological Institute, USSR Academy of Sciences.

CONTENTS

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DETERMINATION AND QUANTITATIVE EVALUATION OF MUTAGENIC FACTORS OF ANTHROPOGENICALLY VARYING HABITAT USING BACTERIAL TEST SYSTEMS

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[Article by R. A. Pshenichnov and Yu. V. Pashin, Institute of Ecology of Plants and Animals, Ural Scientific Center, USSR Academy of Sciences; and Institute of General Genetics, USSR Academy of Sciences]

[Text] Basing themselves on a review of the literature and observation results, the authors describe the optimum variants of bacterial test systems and validate their suitability, economy and promise as a means for screening environmental mutagens. Observation results are presented, and the future directions of research and possible limitations of the method are noted.

The spectrum of chemicals in the environment having genetic effects changed significantly in recent years as a result of swift development of the scientific-technical revolution. Throughout its long evolution the human population has been exposed to natural mutagens; in recent decades, however, the effects of artificially synthesized compounds--ones which the human body as well as animals, plants and microorganisms had not encountered formerly--have assumed dominance. Therefore evaluation of the effect of mutagenic factors in the environment is acquiring important significance, and the need has arisen for developing and introducing test systems that would permit us to reveal, among many new compounds, those which are genetically active, for determining their mutagenic potential and for predicting their effects (2).

Among dozens of test objects used to register mutagenicity, microorganisms--bacteria primarily--are the most sensitive and sufficiently representative. The reasons for this are:

1) Microorganisms are a constant component of all ecosystems, and their diversity, abundance and contribution to the cycling of matter and energy in nature are extremely great. Correspondingly a study of their gene pool and heterogenicity, as formed by the habitat, must become an object of constant attention and supervision.

2) Microorganisms have a minimum reproductive period (measured in minutes and hours), and change in genotypes may be registered within a short time.

3) Bacteria have a haploid set of chromosomes, and disturbance of the genotype is followed immediately by its phenotypic expression. The methods of determining change in phenotype are rather diverse. As a rule they are simple and practicable.

4) Many years of experience in testing hundreds of diverse chemical mutagens have revealed a high degree of correlation in their action upon DNA preparations and upon genetic structures in cultured cells, plants, animals, man and microorganisms (7,8,17).

It should be noted that the principal achievements of modern molecular genetics have involved microorganisms, and primarily bacteria; therefore all data on genetic events occurring in bacteria contain a large amount of information.

Moreover bacterial tests are relatively inexpensive to run, they can be carried out in large numbers, and therefore they may be used extensively in various screening programs. They can be used to detect gene mutations, owing to which rare events can be revealed in large populations within a short testing time. Point or gene mutations that significantly influence the size of the so-called "genetic load" affect only a small part of a gene (about one or two pairs of a total of about 1,000 pairs of bases making up a gene). Substitution, addition or deletion of bases is what usually occurs. Point mutations are usually registered in bacteria as reverse mutations, in which case a specific mutant allele may be reverted by substituting one pair of bases by another, while a mutation associated with shifting of the "reading framework" may be reverted by shifting the "reading framework." Two types of similar cells are used in mutagenicity tests: 1) cells with a normal DNA repair mechanism and 2) cells in which one or several steps of the damaged DNA restoration pathway are absent.

The simplest classical test is performed in Petri dishes seeded with test cultures of *Escherichia coli* (44) or *Salmonella typhimurium* (12, 14). The substance to be tested is applied to the center of each of these dishes, thus creating a gradient in its concentration from the center to the rim. If the substance turns out to be mutagenic a ring of induced mutants forms about it. In this case predominant death of strains with a defective repair mechanism would indicate that a reaction had occurred with cellular DNA, and consequently that the given substance is genetically active. An important prerequisite of these tests is that the substance to be tested must be able to diffuse in agar. If it does not diffuse, the indicator strains may be processed with different concentrations of suspensions of the substance. For practical purposes no difficulties arise with water-soluble compounds.

Since Ames' first works were published, test strains have undergone continual improvement through the introduction of additional mutations (for example ones which can reveal defects in the polysaccharide membrane of a cell that increase its permeability, and defects in the repair system) and through introduction of episomes, use of lysogenic cultures and so on, making them more sensitive than wild strains. Today over 40 strains of *S. typhimurium*, 40 of *E. coli* and about 10 of *Bacillus subtilis* are used for genetic screening; however, only the 20 or so strains shown in the table below have practical significance.

General Characteristics of Bacterial Strains Used Most Often in Genetic Screening (Brusick et al., 1976; 7, 8, 52, etc.)*

(1) Название организма и основной мутации	(2) Штамм	(3) Дополнительная мутация	(4) Выявляемый тип мутационного изменения (эффекта)
Salmonella typhimurium (hys⁻ — hys⁺)	TA-1534 (hys D_{3053})	uvr B	R — FS
	TA-1530		R — BPS
	TA-1535 (hys G_{46})	rfa, uvr B	R — BPS
	TA-1536		R — FS
	TA-1538 (hys D_{3052})	rfa, uvr B	R — FS
	TA-1950 (hys G_{46})	uvr B	R — BPS
	TA-100		R — BPS
	TA-98		R — FS
Escherichia coli (try⁻—arg⁺)	pol A⁻		
	WP_2		R — BPS
(arg⁻—arg⁺)	WP_2 uvr A⁻		R — BPS
	$K_{12}/_{343}/_{113}$		FM
	CM_{661}		R — BPS
	CM_{611}		R — BPS
	W_{3110}/P_{3478}		ER
Bacillus subtilis	H17 Rec⁺		Ингибирование (5) роста
	M45 Rec⁻		

*Symbols: hys--histidine; try--tryptophan; arg--arginine; rfa--mutation increasing cell wall permeability due to defects in the polysaccharide layer; uvr--mutations causing disturbance of excisional repair; R--reverse mutation; BPS--base pair substitution; FS--"reading framework" shift; FM--forward mutations; ER--excisional repair; Rec⁻--recombination insufficiency.

Key:
1. Organism and principal mutation
2. Strain
3. Additional mutation
4. Revealed type of mutational change (effect)
5. Growth inhibition

Because of the high specificity of the test strains, cases may occur in which mutagens are incapable of inducing detectable types of reversions, and therefore the need for constantly seeking and expanding the set of strains with different mutation mechanisms is obvious.

In contrast to mutagenic factors such as ionizing radiation and ultraviolet emissions, chemical compounds undergo complex metabolic biodegradation on entering the organism. In this case mutagens may transform into inactive compounds, while on the other hand genetically inactive substances (indirect mutagens) may acquire mutagenic properties. The metabolic pathways of xenobiotic substances may vary in some ways, but the main role in their biological transformation is played by cytochrome P-450, an element of

the mono-oxygenase system associated with intracellular membranes. This system can be found in a number of microbial species, insects, amphibians, fish, reptiles, higher plants, birds and mammals.

Grin and Goldberger (1) emphasized the biochemical universality of the operation of this system, which is responsible for oxidation of lipid-soluble xenobiotic substances and for their conversion into readily excreted hydrophilic compounds. It is an important component of more-general systems responsible for immunochemical homeostasis (3). Therefore metabolic activation of the tested substance, which may be done *in vivo* or *in vitro*, is a mandatory stage of genetic testing. In the former case the substance to be tested is subjected to metabolism in the body of a mammal (an example would be the recipient medium method), after which it acts upon test microorganisms injected into the abdominal cavity, circulatory system or testicles of the recipient. Indicator cells processed in this fashion are removed and analyzed by a particular method. Indicator microorganisms have also been found useful for revealing the ways of penetration, dissemination and elimination of mutagens with biological fluids--the urine and blood of animals processed by premutagens. However, the latter variant has enjoyed limited acceptance due to the frequent instability of the active form of metabolites in the body.

The "recipient medium" method is not broadly accepted owing to the need for administering large doses of the tested substances, its expensiveness and other reasons such as nonuniform distribution of the active substance in the body and tissue-specific activation or deactivation of the mutagen. An infectious process may arise in mammals given a significant number of test strain bacteria when the recipient is sick, and so on. But even if the recipient remains outwardly healthy, in this case the bacterial test strains would be subjected to the strong influence of the host's protective mechanisms.

The method of metabolic activation by microsomal enzymes *in vitro* has enjoyed the broadest acceptance. Considering the biological universality of the mono-oxygenase system in relation to metabolism of xenobiotic substances, the appropriate enzymatic preparation may be obtained from the tissues of mice, rabbits, rats, Chinese hamsters, dogs, guinea pigs, rhesus monkeys, baboons and man (32,36). Although mono-oxygenase activity is typical of most organs rich in epithelial cells (stomach, intestine, kidneys, lungs, skin), the commonly accepted and proven source of enzyme preparation is liver tissue, which is responsible for more than 90 percent of xenobiotic metabolism. Liver tissue from sexually mature Wistar line male rats is used most often for this purpose.

Although microsomal enzymatic activity is inherent to all healthy organisms, it may be subjected to additional induction and activation by chemical substances present in food and the environment or introduced into the organism by artificial means. It increases when a large number of drugs, food additives, salts of heavy metals, polycyclic hydrocarbons, pesticides and other compounds enter the body. For practical purposes microsomal oxygenases may be induced successfully with sodium phenobarbital, arokhlor, luminal, diazepam and other substances, which are administered intraperitoneally or *per os* for 3-5 days prior to dissection of the animals (18, 31, etc.). Sampled liver tissue is homogenized at a temperature close to 0°, and the obtained preparation is used within the first 2 hours.

Substances to be tested may be metabolically activated by immobilizing the microsomal preparation and the necessary cofactors in agar, or by processing the test strains with a suspension of the substance to be tested (13,33). There may also be cases in which a mutagen cannot be detected (for example a chemical substance may be metabolized not by liver enzymes but by intestinal microflora; the active metabolite may be too unstable to achieve an effective concentration; there may be strongly pronounced metabolic differences between species etc.). On the whole, however, on the basis of 8 years of experience we can confidently recommend microbial test systems as a means for revealing direct and potential mutagens--systems which can be used to study most representatives of all classes of chemical compounds. They have been found to be convenient and effective in revealing the genetic activity of hydrocarbons, their derivatives, drugs, nitro derivatives, nitrogenous bases, nucleotides, nucleosides, salts of heavy metals, inorganic substances, steroids, low molecular weight organic substances, pesticides, herbicides, defoliants, complex mutagens, natural physical factors and so on. They include widespread and rarely encountered compounds, and commonly accepted and "exotic" substances--foodstuffs, food additives, cosmetic dyes, meat curing fluids, fungal toxins, meadow grass extracts, alcohols, waste water, tobacco smoke components, narcotics, and even the combustion products of labdanum and church incense.

We may assert from an analysis of 1,015 works that authors have used the following models with increasing frequency for genetic control: Cytogenic tests in man, tests run on blood cells, experiments with plants, primary and transplanted animal cell cultures, DNA preparations and microorganisms, correspondingly in 5.9, 6.4, 7.5, 15.2, 16.4, 17.2 and 31.3 percent of the works.*

The authors selected microbial test systems from practically a third of all of these works in order to evaluate their genetic effect, and owing to their simplicity, practicability and quickness they were able to evaluate 34, 101, 465 and 855 different compounds in comparable observations within a short period of time (30,50,43,35). A tremendous amount of facts were accumulated, facts which can and must become the basis for making the corresponding conclusions and recommendations on the most suitable use of bacterial tests and for imposing limitations on the use of these methods. These issues were discussed specially in 1978 in Arlington (USA) and Dortmund (FRG), in May 1979 in Banbury (USA), in November 1980 in Ottawa (Canada) and elsewhere. The resulting recommendations have already found their way into some national programs (19,24,49,55).

The International Commission on Protection from Environmental Mutagens and Carcinogens (ICPEMC) and the Environmental Mutagen Information Center (EMIC), created in 1977, are making a major contribution to the creation and standardization of quick screening test systems. In all recommendations and adopted programs, evaluation of the mutagenicity of chemical compounds using bacterial test systems is the first and mandatory stage of analysis. The following are also recommended:

*These percentages are the result of an analysis of the principal Soviet and foreign publications of 1979-1980, including those in the abstract card index "Mutagenic Effects of Chemical Factors" published by the Biology Division of the All-Union Institute of Scientific and Technical Information.

1) using a single set of test strains--TA-1535, TA-1537, TA-1538, TA-98, TA-100 and *Salmonella typhimurium*, and periodically verifying their genotype;

2) working with bacterial cultures undergoing logarithmic growth at a density of $1\text{-}2 \cdot 10^9$ cells/ml;

3) using the S-9 microsomal fraction from the liver of activated rats, preparing fresh preparation each time or developing reliable methods of stabilizing preparations;

4) testing the spontaneous mutability of test strains and performing control tests with known direct and potential mutagens;

5) considering the toxicity of the substance to be tested;

6) determining the dose-effect curve;

7) in the concluding stage it would also be desirable to document the results in a computer program, which would be the formal recording unit and the basis for the program of further tests (21).

It should be noted that most of these recommendations were taken into account in the methodological directives "A Test System for Evaluating the Mutagenic Activity of Environmental Contaminants Using *Salmonella*" (8). Timely publication of these directives played a major role in standardization and development of work in the Soviet Union. The following may be regarded as unsolved problems hindering introduction of bacterial test systems:

the need for creating a single collection of lyophilized test strain cultures;

development and industrial production of dry microsomal fraction preparations;

production of a single standardized outfit containing everything needed for control of substances using bacterial test systems.

The first of these tasks is being worked on by the Institute of Ecology of Plants and Animals of the USSR Academy of Sciences Ural Scientific Center, which has developed the processes and created a collection of lyophilized *Salmonella typhimurium* cultures suited to long-term storage, transportation and use anywhere. It has been demonstrated that lyophilization promotes long-term (more than a year) preservation of the properties of indicator strains.

Researchers have traveled different paths in their search for a stable microsomal fraction. The possibility for long-term storage of this fraction at superlow temperatures on the order of -193°C has been demonstrated (16). However, such long storage and transportation of the preparation were associated with certain difficulties, and thus this approach has not enjoyed widespread acceptance. The Institute of Ecology of Plants and Animals of the USSR Academy of Sciences Ural Scientific Center has developed a semi-industrial method of making lyophilized capsulated microsomal fraction preparation not imposing special requirements on storage and transportation and maintaining its enzymatic activity for more than a year (the time of observation). Industrial production of the preparation is planned to begin in 1982.

Hence we arrive at a possibility for creating a single complex which would include, besides lyophilized indicator cultures of test bacteria and dry microsomal preparation, a complete set of reagents and standard mutagens necessary for positive control. Creation of such a preparation outfit and broad introduction of bacterial test systems are among the priority tasks of the genetic control service.

There are other problems requiring immediate solution as well. As of today more than 3.5 million different chemical compounds are known, and each year up to 80,000 more are synthesized, of which 30,000 are produced on an industrial scale. A selective study has shown that about 20 percent of them exhibit some level of genetic activity (2,54). Naturally we could hardly expect testing of all of them in the foreseeable future.

We also know that in natural conditions these substances act upon the bodies of man and animals, plants and microorganisms not in isolation but as various combinations, with the ingredients present in different concentrations. This means that co-mutagenic action (activation of potential mutagens by nonmutagenic substances) and the effects of summation, amplification or attenuation are possible (15,25,27,37,45,56). A large number of observations have shown that temperature fluctuations, the action of electric and magnetic fields, light-induced activation, and the composition of the medium in which mixtures act have a certain influence on the end effect of mutagens (20,22,26,34,41).

Hence arises a new and great important problem--development of ways for determining the cumulative action of mutagens in the three principal environments (air, soil, water). This would allow us to adopt a new, more sensible approach to organizing the genetic control service--primary mapping by means of summational tests, revelation of zones of high genetic danger and subsequent determination of the concrete causes behind this danger. For the moment we can cite only a limited number of studies based on this approach. They include an evaluation of the total mutagenic activity of soil water in the Surgut petroleum-gas region and of the waters of the Mississippi, and mapping of mutagens in the atmosphere above Norway (4,11). A similar approach would also be sensible for analyzing the possible mutagenic danger of multiple-ingredient local mixtures--industrial wastes, gas exhausts and so on.

In the opinion of specialists, as reflected in recommendations of a symposium of the Canadian Society of Geneticists, determination and quantitative evaluation of the action of individual mutagens or their combinations is not yet enough to allow prediction of the end results of change in the gene pool of human, animal, plant and microorganism populations within the limits of a closed ecosystem, and all the more so an open ecosystem. We would have to agree with the opinion that the influence of mutagens upon a population should be evaluated on the basis of the size of the genetic load and the frequency of arisal of hereditary pathology (38). This is why increasingly greater significance has been attached in recent years to developing a system of genetic monitoring or surveillance of the dynamics of the genetic load in human, animal and plant populations in space and in time (9,10,28,29,39,48,51).

In the Soviet Union, the Interdepartmental Scientific-Technical Council on Complex Problems of Environmental Protection and Sensible Use of Natural Resources has foreseen development of genetic monitoring of human populations (the Institute of General Genetics) and a similar system for natural bacterial populations (the Institute of

Ecology of Plants and Animals of the USSR Academy of Sciences Ural Scientific Center). The object of the observations is the ubiquitous indicator species *E. coli commune*. Research is embracing all of the basic units of the species' natural circulation (healthy people, drinking water, domestic wastes, open-air water basins) and groups of clones isolated from industrial wastes containing a high concentration of chemical mutagens, from the cooling ponds of atomic electric power plants and from patients subjected to intensive antibiotic and chemotherapy.

The system used to describe the gene pool of natural populations includes the following genetically determined and ecologically significant characteristics: a) prototrophism, or auxotrophy, with the type of trophic dependence being stated; b) reproduction dynamics on solid and liquid media, with K_r, t_d, M_m, X_m, t_{xm} and Y_E recorded; c) the possibility of utilizing basic carbohydrates and alcohols for development; d) antagonism in relation to accompanying bacterial flora; e) sensitivity to bacteriocins produced by satellite microbes; f) resistance to the principal antibiotics, activated chlorine, ultraviolet light and so on. The obtained results are subjected to biometric treatment, systems analysis and computer comparison. In this case *E. coli commune* is the indicator microbial species, and periodic analysis of the gene pool of its natural populations would obviously allow us to evaluate the resulting action of anthropogenically changing natural factors and of regulatory mechanisms within populations (6).

Summing up the published data and the results of our own observations, we should note at the same time that bacterial test systems, as with any other method, have their limitations. Some researchers (40,42,47) feel it impossible to use this approach to reveal all genetic damage, to test all antimicrobial agents and to reveal carcinogens activated by other means, apart from liver microsomes. Full quantitative correlation is not always revealed in experiments using bacterial and other more-complex systems.

But this does not in any way reduce the value of bacterial test systems, which are a mandatory stage of screening and the simplest, most convenient and fastest model, and when combined with selective tests run on animal cell cultures (5,23), they allow us to reveal and quantitatively evaluate the genetic effect of all substances, their mixtures and other environmental factors. This system has already received international recognition, and it will enjoy even broader acceptance in the future.

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^{90}Sr AND ^{137}Cs ACCUMULATION BY SOME LOWER PLANTS IN VICINITY OF BELOYARSKAYA ATOMIC POWER PLANT IN THE URALS

Sverdlovsk EKOLOGIYA in Russian No 6, Nov-Dec 81 (manuscript received 27 Mar 81) pp 94-97

[Article by M. G. Nifontova and N. V. Kulikov, Institute of Ecology of Plants and Animals, Ural Scientific Center, USSR Academy of Sciences]

[Text] Considering the future of atomic power, the laws governing migration and accumulation of artificial radionuclides in components of natural ecosystems at the locations of industrial atomic electric power plants (AES) are an extremely important object of study. Such components may include the lower plants, representatives of which (the lichens for example) are capable of greater accumulation of radioactive and stable nuclides (3,4,8).

This paper presents data on the concentration of ^{90}Sr and ^{137}Cs in the thalluses of the leafy epiphytic lichen *Hypogymnia physodes* (L.) Nyl. and in a number of widespread species of edible fungi growing in forested areas of the health protection zone of the Beloyarskaya AES in the Central Urals: agaric--*Russula cyaxantha* (Schw.) Fr., birch mushroom--*Leccinum scabrum* (Fr.) S. F. Gray, pepper mushroom--*Lactarius resimus* Fr., and the valuy [transliteration]--*Russula foetens* (Fr.) Fr.

The plant samples and their substrates (birch, pine and brushwood bark for lichens and the upper layer of forest litter and soil to a depth of 0-5 cm for fungi) were taken from 50×50-meter sampling areas in three to six repetitions in July-August 1978-1979. Then the material was dried and reduced to ash at 450-50°C. ^{90}Sr was determined* radiochemically by the presence of daughter ^{90}Y, and ^{137}Cs was determined with an AI-128-2 scintillation gamma-spectrometer with an 80×80 mm NaI(Tl) crystal and a 24×40 mm socket. The statistical error of the analyses did not exceed 10-15 percent.

As we can see from Figure 1, the concentration of ^{90}Sr in epiphytic lichen growing on various substrates varies from 5.8 to 9.4 nanocuries, while that of ^{137}Cs varies from 9.5 to 17.9 nannocuries per kilogram dry weight. These magnitudes do not exceed the concentration of radionuclides in similar groups of lichens from other regions of the country subjected to worldwide radioactive atmospheric fallout (4). The concentration of ^{90}Sr and ^{137}Cs in different substrates is practically the same, and it is several times lower than in lichens growing on these substrates. In this case we did not note any dependence between accumulation of radionuclides in lichens and

*The authors express their deep gratefulness to S. Kh. Fakhrutdinova and S. I. Rossolenko for their assistance in radiometric processing of the preparations.

their concentration in the substrates. The latter indirectly confirms that the principal source of ^{90}Sr and ^{127}Cs taken up by epiphytic lichens is not the substrate upon which they grow but atmospheric precipitation and water draining from tree crowns, enriched by radionuclides to a certain degree.

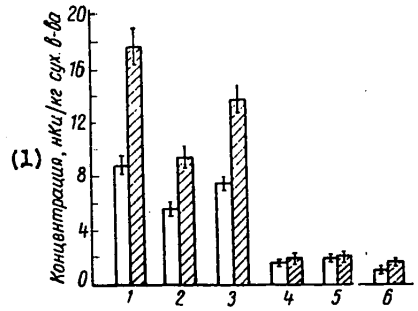

Figure 1. Concentration of ^{90}Sr (Empty Columns) and ^{137}Cs (Cross-Hatched Columns) in Thalluses of *Hypogymnia physodes* and Substrates: *1-3*--lichens (*1*--from birch, *2*--from pine, *3*--from brushwood); *4-6*--substrates (*4*--birch, *5*--pine, *6*--brushwood)

Key:
1. Concentration, nanocuries/kg dry weight

The concentration of radionuclides in edible mushrooms was about an order of magnitude lower than in lichens (Figure 2), which is explained mainly by the life span of the objects studied. Epiphytic lichens usually live several decades, and consequently they accumulate radionuclides in their thalluses for many years. The life span of the fruiting bodies of mushrooms is limited to several days (5). Moreover, as was noted above, lichens accumulate radionuclides from atmospheric precipitation and from water draining off of tree crowns; the principal source of radioactive products in the fungal mycelium is the substrate itself--that is, soil and litter, in which ^{90}Sr and ^{137}Cs exist predominantly in a bound form with low mobility (2). Figure 2 also shows that these radionuclides are not readily available to the fruiting bodies of mushrooms. We can see that the concentration of radionuclides in fungi is significantly lower than in the substrate. In this case the accumulation coefficients are only 0.07-0.09 for ^{90}Sr and 0.18-0.22 for ^{137}Cs. Consequently, given uptake of both nuclides by the fruiting bodies of mushrooms, they are noticeably enriched by radioactive cesium in comparison with ^{90}Sr. The concentration of ^{90}Sr and ^{137}Cs in the caps of the fruiting bodies of some mushroom species is somewhat higher than in the stems (Figure 3). But on the whole the concentration of these isotopes in edible mushrooms living in the health protection zone of the Beloyarskaya AES does not exceed amounts explainable by worldwide radioactive fallout, inasmuch as the same concentrations of radionuclides were noted for mushrooms in the Lithuanian SSR (1), the FRG (6) and a number of other countries (7).

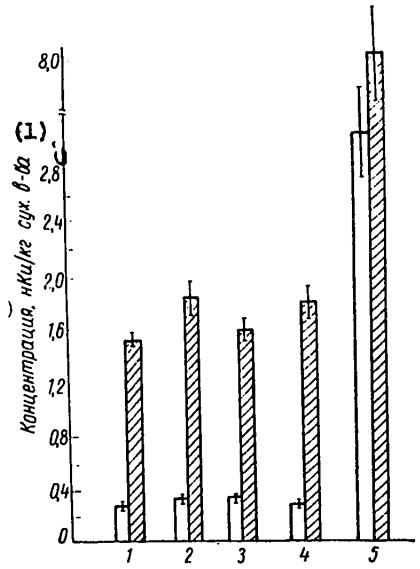

Figure 2. Concentration of ^{90}Sr (Empty Columns) and ^{137}Cs (Cross-Hatched Columns) in Fruiting Bodies of Agaric Mushrooms and in Substrate: *1--Russula cyaxantha; 2--Leccinum scabrum; 3--Lactarius resimus; 4--Russula foetens; 5*--soil

Key:
1. Concentration, nanocuries/kg dry weight

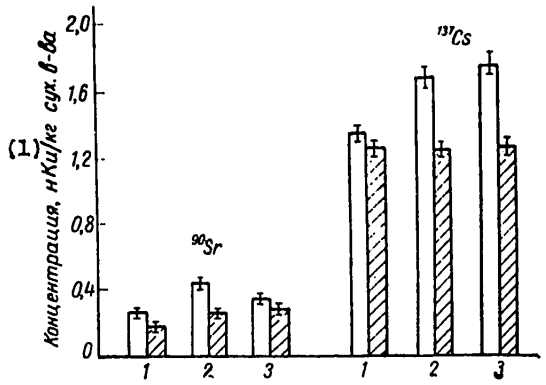

Figure 3. Concentration of ^{90}Sr and ^{137}Cs in the Caps (Empty Columns) and Stems (Cross-Hatched Columns) of Mushroom Fruiting Bodies: *1--Russula foetens; 2--Russula cyaxantha; 3--Lactarius resimus*

Key:
1. Concentration, nanocuries/kg dry weight

Thus the data presented here permit the assumption that the concentration of ^{90}Sr and ^{137}Cs in epiphytic lichens and edible agaric mushrooms in the vicinity of the Beloyarskaya AES does not exceed the background concentration of these radionuclides typical of similar plants from other habitats outside the possible influence of the AES.

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COLLABORATION OF U.S. AND SOVIET SCIENTISTS IN LEGAL PROTECTION OF THE ENVIRONMENT

Moscow VESTNIK AKADEMII NAUK SSSR in Russian No 8, Aug 81 (signed to press 4 Aug 81) pp 102-109

[Article by O. S. Kolbasov and M. I. Kozyr', doctors of law]

[Text] In the second half of the 20th century, environmental protection has become one of the most serious global problems, the solution of which requires coordinated effort on the part of all countries of the world.

Enormous and valuable knowhow has been accumulated in the Soviet Union in the area of environmental protection; relevant laws have been elaborated and successfully implemented. The communist party and Soviet government attribute much importance to further intensification of measures for protection of the environment and devote their constant attention to this matter.

Article 18 of the USSR Constitution states: "In the interests of the present and future generations, the necessary steps are being taken in the USSR to protect and make wise use, with scientific validation, of the land and its mineral resources, water resources, the plant and animal kingdom, to preserve the purity of air and water, implement reproduction of natural resources and improve man's environment." There is a special section in "The Main Directions of Economic and Social Development of the USSR in 1981-1985 and for the Period up to 1990," which were approved at the 26th CPSU Congress, concerning environmental protection, and in the section listing the main objectives of economic and social development of our nation for the future period it is stated: "There must be intensification of protection of nature, the land and its mineral resources, atmospheric air, water reservoirs, animal and plant kingdom. Wise use and reproduction of natural resources must be implemented."

The Soviet Union is actively in favor of continued development and deepening of international collaboration in the area of environmental protection. Constructive proposals on this subject are constantly offered at party congresses, sessions of the USSR Supreme Soviet, in speeches of Soviet representatives in various international forums.

Much work on environmental protection is being pursued in the United States of America; considerable knowhow has been accumulated there, particularly with regard to refinement of laws and management in this area.

In view of the enormous importance and acuity of the problem, as well as the need to combine forces for environmental protection, the governments of the USSR and United States signed an agreement on collaboration in the area of environmental protection on 23 May 1972, in Moscow.

Soviet-American collaboration is directed at solving the main aspects of the problem of the environment and developing bases for regulating the effects of human endeavor on nature with, of course, consideration of the differences in socioeconomic and political systems of these two countries. The main aspects of this collaboration are: prevention of air and water (including the marine environment) pollution; protection of the environment against the adverse effects of agriculture and other industries, improvement of the ecological environment of cities, organization of reservations, forecasting earthquakes, study of biological and genetic consequences of environmental pollution, regulation of the effects of human endeavor on climate, investigation of the distinctions of arctic and subarctic ecological systems, analysis of various legal and administrative measures to preserve the quality of the environment.

One or several joint projects and collaborating organizations were assigned for each of the above problems. The forms of work were defined: exchange of scientists, specialists and trainees, as well as scientific and technical information, documentation and results of research, holding joint symposiums, conferences and meetings of experts, joint development of specific scientific programs, etc. The plans for such work are approved at annual meetings of the Soviet-American commission, which is jointly headed by the chairman of the USSR State Committee for Hydrometeorology and Control of the Environment and director of the Environmental Protection Agency (EPA) of the United States.

In view of the fact that work on legal and administrative measures for environmental protection touches upon many common problems of government and law, the Institute of Government and Law, USSR Academy of Sciences, was named as the chief organization for the Soviet side (since 1972, there has been a sector at this institute working on legal problems of environmental protection). The Council on Environmental Quality under the U. S. president is the chief organization on the American side.

Since this collaboration started, there have been five 2-week conferences of experts (in 1973, 1976 and 1980 in the United States; in 1974 and 1978 in the USSR); two American specialists spent 5 months in the Soviet Union in training, there was regular exchange of literature and information on legislation and practical use thereof, consultations were offered on different questions of law and management in the area of environmental protection, assistance was given in establishing direct contact between public environment protection organizations of the USSR and the United States. Of course, personal meetings of specialists and expert conferences were also very important.

At the meetings of specialists, there was discussion of such important topics as the correlation between international and national law in environmental protection, correlation between law and management on different levels (all-Union--federal, republic--state, etc., down to the level of individual enterprises); legal forms of participation of the USSR and United States community in environmental protection.

Exchange of opinions, knowhow and information on these pressing problems, joint work on theoretical conceptions in the area of law and administration are instrumental in mutual enrichment of theory and practice on both sides, dissemination over the entire world of knowhow in environmental protection of the two large industrial countries, strengthening the spirit of mutual understanding of the Soviet and American peoples.

While visiting the country in which a meeting of experts is convened, the scientists of the other side have the opportunity to learn about environmental protection in the host country, the nature of activities of environment protection organizations, the work of reservations and national parks.

Thus, American specialists, who came to the Soviet Union in 1974 and 1978 learned about the work of state agencies and public organizations concerned with environmental protection in Moscow and Moscow Oblast, Kazakh SSR, Kiev, Baku, Tashkent, Vladimirskaya and Rostovskaya Oblasts. In particular, they visited the Botanical Garden of the Institute of Botany imeni V. L. Komarov, Azerbaijan Academy of Sciences, the Kanevskiy Preserve and marine oil wells in Baku. They talked with the staff of the Presidium of the USSR Supreme Soviet, chairman of the Commission for Environmental Protection of the RSFSR Supreme Soviet and members of the Presidium of the Supreme Soviet of Azerbaijan SSR, representatives of the USSR Supreme Court, USSR Ministry of Justice, RSFSR Ministry of Agriculture, Vladmirskaya and Rostovskaya oblispolkoms, agencies for protection of fish reserves and supervision of hunting, administrators of the All-Russian and Kazakh environmental protection societies, as well as Rostovskaya Oblast organization of the All-Russian Society for Environmental Protection, etc. In 1978, an agreement was made for establishment of direct contact between the All-Russian Society for Environmental Protection and the American Sierra Club, and in accordance with this agreement, American public figures concerned with environmental protection made their first visit to the USSR in 1979.

American specialists and public figures who visited the USSR praised the work conducted in our country in the area of environmental protection. Such a rating was reflected in the speech of (J. A. Basterud), a member of the Council on Environmental Quality, at the Internal Expo-74 exhibition in Spokane. Prof T. (Shoenbaum), who studied for several months the organizational and legal measures for the protection of reserves in our country, published an article entitled "Protected Preserve Regions in the Soviet Union and United States. Comparative Aspect," in the AMERICAN JOURNAL OF COMPARATIVE LAW, in 1976, where he shed light on our achievements in this area and recommended that some elements of Soviet knowhow in legal regulation of protection of reserves be used in the United States. Representatives of American public organizations who visited the USSR in 1979 gave a high rating to the statutes in the USSR Constitution pertaining to environmental protection.

In turn, Soviet specialists had the opportunity of learning about organization and content of the work of the Council on Environmental Quality, EPA and some of its peripheral departments, the work of the U. S. congress permanent commissions, the Departments of Justice, The Interior, Agriculture, the Atomic Energy Commission, the U. S. Supreme Court and certain other regional and state courts, environmental protection organizations in Washington, New York,

Boston, San Francisco and Los Angeles. They visited Grand Teton, Yellowstone and Grand Canyon National Parks, learned about the work on redeveloping land in the coal mines of the (Deker) Mine Company (Montana), protection of water and atmospheric air at the Kennecott Copper copper and molybdenum enterprise (Utah), and participated in seminars in Denver (Colorado) and Salt Lake City (Utah).

The fifth conference of Soviet and American specialists on legal and administrative aspects of environmental protection was held in December 1980, in the United States (Washington, Miami, Atlanta and New York). The American delegation was headed by F. Knight, who performed the duties of the chief jurist of the host organization, the Council on Quality Environmental. The delegation consisted of prominent specialists: N. Yost, director of the president's working team for preparation of a global ecological forecast up to the year 2000, J. Moorman, head of the Land and Natural Resources Division, U. S. Department of Justice, G. (Widman), deputy director of the juridical service of the Dept. of the Interior, E. Greenberg, head of the juridical service of the National Oceanic and Atmospheric Admin. of the Dept. of Commerce, (V. Smith), chief economist of the EPA, N. Robinson, member of the board of directors of the Sierra Club, O. Hook, vice-president of the National Wildlife Federation, (V. Futrell), president of the Institute of Environmental Law, members of different departments and agencies, K. (Hall), B. (Bramble), G. (Osherenko) and D. (Shay).

The Soviet delegation included O. S. Kolbasov (head), M. I. Kozyr', Yu. S. Shemshuchenko, A. M. Kaverin and Yu. A. Starikov.

In his opening remarks at the conference, F. Knight stressed the fact that collaboration of the United States and the USSR on a very difficult problem affecting the interests of all countries of the world--environmental protection--was quite fruitful.

O. S. Kolbasov noted the importance of Soviet-American collaboration in the area of environmental protection, indicating its place and role in the system of measures to preserve peace, improve the general political climate, as well as living conditions. He informed the audience of measures implemented in recent years in the USSR to protect the environment and stressed that a very important place is given to environmental protection in the draft of the "Main Directions of Economic and Social Development of the USSR in 1981-1985 and for the Period up to 1990."

During the meeting, Soviet and American specialists discussed issues related to the need and mandatory nature of considering ecological aspects and questions pertaining to the environment in elaborating construction plans, with analysis of the role in this process of the U. S. EPA and analogous state organizations. In particular, determination was made of the extent to which this agency takes into consideration economic factors in making decisions related to environmental protection. We sensed a concern on the part of the agency with the fact that the supposedly strict laws, as well as EPA rules for environmental protection, which supposedly held back development of the economy were submitted to excessive criticism during the period of the pre-election campaign in the United

States in 1980, and the opinion was voiced that it was necessary to strictly "straighten out" the EPA officials and reduce expenses for environmental protection.

During the meeting there was also comprehensive discussion of global environmental protection, international mechanisms of assessing the environment and problems of environmental protection in the entire world.

American specialists acquainted the Soviet scientists with an abstract published in July 1980 of a report to the president of the United States, which contained an ecological forecast for the year 2000.

> In the opinion of the authors of the report, in the year 2000 earth's population will be 6.35 billion, and 90% of the population growth will occur in developing countries. By that time, foodstuff production will almost double; however, the increase per capita will be less than 15%. There will be an even greater discrepancy between the economic welfare of the people of developed and developing countries: industrially developed countries (one-quarter of the world's population) will, as before, consume three-quarters of the worldwide mineral resources. A water shortage will increase in some parts of the world. There will be a 50% decrease (per capita) in stock of growing timber of commercial size; in developing countries, about 40% of the remaining forests will be removed. In view of the serious changes in living conditions, perhaps up to 20% of the existing species of animals and plants will disappear forever. It is expected that the atmospheric concentration of nitrogen dioxide and other chemicals that destroy ozone will increase at such a rate that they will alter appreciably earth's climate by the year 2050. In spite of the fact that an increasing effort is being applied at the present time to protect the environment, in the opinion of the authors of this report this is obviously insufficient and cannot alter the negative ecological trends. At the same time, the authors did not take into consideration the real economic and political difficulties that prevent people from forming their relations with nature more wisely, and this increases even more the seriousness of the looming problems.

No concrete plan of actions was advanced in this report to correct the ecological situation (work is not yet finished on the third volume thereof, which contains recommendations on models of behavior of U. S. management in implementation of ecological policies). It merely offers general recommendations: to display more initiative in solving ecological problems, elaborate global complex and long-term programs of environmental protection that should "inaugurate an era of unprecedented collaboration and selflessness" of all peoples of the world. The authors of this report maintain that, at the present time, all of the opportunities are available, as well as weighty grounds for the United States to become a world leader in the movement for environmental protection.

Soviet specialists found the report quite interesting and considered that its material merited careful investigation. At the same time, they stressed the fact that so long as there is a real threat of thermonuclear war because of

those who oppose detente, and there is intensification of the arms race, it is difficult and unrealistic to speak about "unprecedented international collaboration" in the area of environmental protection. As for leadership of the United States in the international environmental protection movement, it could be accepted by the international community only if it is implemented with no detriment to and not at the expense of other nations, if it becomes a leadership through good examples and assistance to needy nations.

The scientific papers delivered by members of the Soviet delegation offered in-depth and comprehensive analysis of different aspects of existing Soviet legislation for environmental protection, including preventive measures, and it was noted that questions of environmental protection are taken into comprehensive consideration in our country in preparing construction plans, and that a thorough ecological expert evaluation is made of such plans. The speakers gave detailed information on the content of new Soviet laws on protection of atmospheric air, protection and use of the animal kingdom; they told about the procedures for planning wise use of natural resources and environmental protection in the area of agriculture, the juridical guarantees for land protection and improvement of soil fertility.

The American participants displayed much interest in the information about development and use of laws for environmental protection in the USSR, and voiced their interest in strengthening Soviet-American collaboration in the area of environmental protection.

During their stay in the United States, the Soviet specialists had comprehensive talks with American specialists dealing with legal and administrative problems of environmental protection in the USSR and United States, the EPA, U.S. Departments of The Interior, Commerce and Justice, as well as at the Kennan Institute and Institute of Environmental Law in Washington. They discussed with M. (Wilkie), a member of the Federal Court of Appeals of the District of Columbia, the question of the role of U. S. courts in the area of environmental law. They had talks with government officials of several states and some local agencies on the effectiveness of using federal and state laws, rules and procedures for environmental protection, with representatives of U. S. public organizations concerned with environmental protection, in particular, with activists of the Sierra Club and National Wildlife Federation, as well as prominent practicing jurists concerned with legal problems of environmental protection and professors on the faculty of law at Pace University.

The members of the Soviet delegation visited the national Everglades preserve, a farm near Miami (Florida), a heat and electric power plant and regional department of the EPA in Atlanta, the department for environmental protection of the state of New York, a gas plant near Calvert Cliffs (Maryland) and were received the Mayor of Greenburg, New York.

During these meetings, American figures in the area of environmental protection displayed much interest in Soviet knowhow and praised it highly. Thus, J. W. Moorman, assistant attorney general; Land and Natural Resources Division, Dept. of Justice, voiced his admiration to Soviet specialists for setting up well the job of protecting the environment in the USSR; in several of his speeches Prof

N.A. Robinson rated highly the collaboration between the Soviet Union and the United States, with reference to legal and administrative problems of environmental protection, repeatedly citing articles 18 and 58 of the USSR Constitution as a model of responsible attitude toward environmental protection, calling for further expansion of collaboration in this area. The major American specialists, N. Yost and O. Hook, made similar statements.

How can one assess the current status of American law and government, and their role in environmental protection?

In the opinion of Soviet specialists, some progress in legal protection of atmospheric air and coastal zones of adjacent seas has been made in the United States in the last decade (in previous years, there were mainly measures to protect waters and regulate land use on the basis of territorial zoning).

Worthy of especially careful study is, in our opinion, the effective use in the United States of a new legal institution, "Declarations on Effects on the Environment," referable to construction of various industrial projects and facilities (gas and pipe lines, dams, hydroelectric power stations, irrigation canals, etc.), which is a rather powerful means of preventive control [inspection] that American specialists believe helped increase significantly the ecological validation of management decisions avoid mistakes and improve effectiveness of environmental protection. The American specialists recommend the use of this form by other countries, as well as in international relations.

This system of preliminary ecological control is implemented in industry in accordance with the Law on National Policy in the Area of Environmental Protection (January 1970) and analogous laws in certain states. The laws stipulate that, at specific times prior to construction and remodeling of enterprises and other economic facilities, the entrepreneurs and state agencies must make a public "declaration on effects on the environment" of these installations. The contents of the declaration are analyzed for a specific time by state inspection [control] agencies, public organizations and the local public, who can voice objections for ecological reasons against a particular project as a whole, propose alternative variants or corrections to the plan. Entrepreneurs and state agencies must examine the corrections and, within a specific time, announce whether they are accepted or rejected. If the authors of the comments and proposals are not satisfied with the results of this examination, they can file suit to force implementation of their suggestions. To date, several tens of thousands of declarations on effects on the environment have been examined on different levels of the American governmental structure; up to 5% of them have been disputed in the courts.

However, by far not all of the important aspects of legal environmental protection in the United States could be studied during the years of collaboration. There is still a need for deeper investigation of the system, functions and interaction in environmental protection of American state agencies, which include, in particular, the U. S. Department of Justice, Council on Environmental Quality under the U. S. president and the Environmental Protection Agency.

The system of preventive environmental protective measures in U. S. agriculture, as well as the adverse effect of industrialization and particularly use of

chemistry in agriculture on the environment have not been adequately studied either.

It is of great interest to Soviet jurists--scientists and practitioners--to study the practice of examining environmental protection cases in the American courts and to analyze measures of liability [as to property] for the detriment to the environment (for example, fines of $25,000 for each day of violation).

International environmental protection measures of the United States, their place in the general policy of this state, as it applies to different parts of the world as a whole, but particularly as it relates to food aid for developing countries, also merits investigation. Finally, we must also study the aspects of American theory and practice that are related to development of international environmental laws.

As for assessment of the current status of Soviet-American collaboration in law and administrative problems of environmental protection, it was formulated as follows in the summary minutes of the meeting: "Both sides observed that the fifth meeting was successful and that there was satisfactory exchange of information and knowhow. The specialists conceded that there is a need to continue with the exchange of opinions, information and documents, and observed that collaboration on environmental issues on a worldwide scale is very important and merits increasing attention."

The minutes also formulated the main directions of collaboration in 1981-1982. As before, there will be continued exchange of information and opinions concerning elaboration and use of legislation on environmental protection in the USSR and United States. There will be continued exchange of information about research and evaluation of effects on the environment, both within each nation and on earth as a whole, about comparison of economic factors to environmental factors, implementation of laws pertaining to the environment. Exchange of scientists and students concerned with legal and administrative aspects of environmental protection will be continued.

It was also decided to examine the question of the means of future collaboration of the USSR and United States in the area of long-term problems of environmental protection and wise use of natural resources on an international scale.

It is planned to discuss all these problems at the sixth meeting of Soviet and American specialists, which is to be held in the USSR in 1982.

The participants at the meeting agreed to explore the possibility of joint preparation and publication in both countries of a collection of articles dealing with evaluation of environmental protection on the national and international levels, use of legislation, as well as analysis of administrative measures in the area of environmental protection that are being implemented in the USSR and United States.

With reference to the results of 9-year Soviet-American collaboration on legal and administrative problems of environmental protection, it should be noted that the main achievement was deeper knowledge of theory and practice of legal regulation in the area of environmental protection, in both countries and in the system of international law.

Aside from its direct professional usefulness, collaboration was instrumental in maintaining a spirit of trust and mutual understanding between the Soviet and American people.

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LOW-FREQUENCY ACOUSTIC VIBRATIONS IN INDUSTRY

Moscow NIZKOCHASTOTNYYE AKUSTICHESKIYE KOLEBANIYA NA PROIZVODSTVE in Russian 1981 (signed to press 22 Aug 80) pp 2-5, 190-191

[Annotation,, introduction and table of contents from book "Low-Frequency Acoustic Vibrations in Industry" by Nadezhda Ivanovna Karpova and Eduard Nikolayevich Malyshev, Izdatel'stvo "Meditsina", 1266 copies, 192 pages]

[Text] This monograph is concerned with hygienic evaluation of infrasonic waves in industry, their biological effects on man and animals, and prevention of their deleterious effects. For the first time, information is systematized concerning the physical nature and distinctions of infrasonic waves. Techniques are described for measurement and estimation of infrasound in industry. Methods are discussed for conducting tests on man and experiments on animals to study reactions to low-frequency vibrations. The authors' own data, as well as those of the staff of the Department of Industrial Hygiene, Leningrad Medical Institute of Sanitation and Hygiene, obtained using modern investigative methods, which describe the influence of industrial parameters of subsonic vibration on the subjective state of man and functional changes occurring in the central nervous, cardiovascular and respiratory systems, as well as analyzers and viscera are presented. Special attention is given to the approach to setting standards of subsonic vibrations in industry. In conclusion, measures are listed for the prevention of the deleterious effects of industrial infrasonic waves of specific parameters and medical preventive measures. This monograph fills a gap in the literature, since there are no such works either in our country or abroad. It is intended for industrial hygienists, occupational pathologists, industrial health inspectors [physicians], engineering and technical workers, as well as other specialists concerned with the study of industrial noise, control of noise and infrasonic waves.

Introduction

The decisions of the 25th CPSU Congress provide for further improvement of working conditions that would be instrumental in lowering morbidity and increasing labor productivity in all sectors of industry.

Intensive scientific and technological progress is leading to development of high-power equipment and machines. However, operation of such equipment is not infrequently associated with considerable noise. Infrasound, which did not attract the attention of scientists for a long time, is a constant companion of noise.

Infrasound varying in intensity and frequency is always present in our environment, particularly in large cities with well-developed industry and intensive transportation. Man may be exposed to low-frequency sonic vibrations at work and at rest.

There are natural sources of infrasound. Many natural phenomena, such as earthquakes, eruptions of volcanoes, thunder, landslides, hurricanes, storms at sea, large waterfalls, aurora borealis, generate infrasonic waves. In addition to natural sources, more and more often man is exposed to increasing levels of infrasound occurring in industry and transportation as a concomitant factor of technological processes.

Infrasonic waves are formed during operation of compressors, turbines, diesel engines, electric locomotives, air-conditioning systems, commercial fans and other large machines and equipment.

With the development of technology, machines are appearing that are large in size, operating at high speed and high power, whose function is associated with excitation of intensive low-frequency sonic waves. Modern technology is increasing the noise background in industry, which has a broad spectrum and increasing intensity.

Various forms of transportation are also artificial sources of infrasound: seafaring, railroad, aviation, including jet aircraft and the high-power engines used in space flights (R. W. Stephens, 1969, 1974; W. Tempest, 1971). Man's exploration of space generates noise during launchings that has maximum energy in the low-frequency part of the spectrum, in the range of 1 to 100 Hz. Infrasonic vibrations are not only a component, but in many cases the prevailing part of spectra of industrial noises. At the present time, the effects of industrial noise in the acoustic range of frequencies on man have been studied rather well.

There is extremely little information in the Soviet and foreign literature about the biological effects of low-frequency vibrations. The data in the literature are disparate and often contradictory. There are few sources with systematized data on the biological effects of infrasound.

Studies have revealed that man is sensitive to low-frequency vibrations and compel us to admit that the problem of studying the effect of infrasound on man merits the very closest attention.

Infrasound may be one of the deleterious factors of the industrial environment. Certain levels of infrasound may be deleterious to human health. It affects the entire human body, man's health and work capacity.

Most workers in modern industry and transportation are exposed to such a little-studied factor as infrasound. This puts to industrial hygienists the task of comprehensive investigation of the distinctions of its biological action in order to determine the degree of harm of low-frequency sonic vibrations, set hygienic standards and elaborate measures to eliminate the deleterious effects of some parameters of low-frequency vibrations on workers.

Because of the distinctions of propagation of infrasonic waves and their difference from audible vibrations, the study of biological effects of infrasound requires new methodological approaches to set the scientifically substantiated range of permissible levels of infrasonic pressure and develop optimum ameliorative measures. It is very important to determine the threshold intensity of infrasound with acute and chronic exposure to it, as well as to demonstrate the physiological mechanisms of the body's reactions to infrasound.

The objective of this book is to acquaint the reader with infrasound as a deleterious factor of the industrial environment, as well as experimental data from studies of biological effects of infrasound of industrial parameters on animals and man.

This work summarizes the knowhow of Soviet and foreign authors in the area of studying the biological effects of low-frequency vibrations, as well as the results of studies conducted by the authors and staff members of the Department of Industrial Hygiene of the Leningrad Medical Institute of Sanitation and Hygiene and Department of Industrial Safety of the Leningrad Institute of Railroad Engineers.

It is imperative to widen the front of scientific research in this interesting branch of science.

CONTENTS

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ANALYSIS AND OPTIMIZATION OF CONTROL SYSTEMS FOR MANNED AIRCRAFT

Moscow ANALIZ I OPTIMIZATSIYA SISTEM UPRAVLENIYA PILOTIRUYEMYKH LETATEL'NYKH APPARATOV in Russian 1981 (signed to press 2 Jun 81) pp 2-8, 200

[Annotation, introduction and table of contents from book "Analysis and Optimization of Control Systems for Manned Aircraft", by Grigoriy Illarionovich Ryl'skiy, Izdatel'stvo "Mashinostroyeniye", 1240 copies, 200 pages, illustrated]

[Text] This book analyzes the performance of operators in control systems (CS) of manned aircraft, as well as the possibility of describing it mathematically. A classification is proposed and analysis made of modern mathematical models that describe certain forms of human work in aircraft control systems. The advantages are shown of models that make use of queueing theory, and new engineering methods were developed on the basis of these models for demonstrating the characteristics of human operators. This book is intended for engineers involved with the design and operation of a broad class of man-machine control systems.

Introduction

The cybernetic problem of refining control of various systems (engineering, biological, economic, management [organization], man-machine, etc.) is a rather pressing one. The most important element of this problem is to find optimum variants of organization of structure and processes of control in such systems. The concept of system emerged as a result of development of engineering disciplines, since it is expressly the increasing complexity of various technical systems that made it necessary to elaborate methodology that would help integrate all parts of such systems. At the present time, there are quite a few definitions of system. However, there is still no conventional [generally used] definition. Each researcher gives this concept his own special content and singles out essentially the element of the system that he submits to investigation (see, for example, the works of foreign [2, 58, 79, 92, 101, 107, 117, 121, 129, 135, 136] and Soviet [7, 43, 77, 78, 109, 113, 119, 125, 130, 146, 147] authors).

In this book, system is used to refer to the aggregate of elements that are interlinked into a specific structure. With such an approach, industrial, educational and research organizations, man-machine systems, equipment, etc., can be considered to be a system.

Systems with infinite diversity can be classified according to a number of features: purpose, complexity, level of automation and others.

Control systems (CS) are an extremely important class of systems, which are used to control other systems (aircraft, plant, etc.). Consequently, such systems must have the purpose of functioning and, moreover, must have the capacity to alter the parameters (characteristics) and structures of elements and of the entire system in accordance to this functioning purpose. Control systems, in which man is an element, are called automated, ergatic, anthropotechnical, organizational systems or man-equipment (man-machine) systems. It must be noted that all of these definitions refer chiefly to man-machine control systems (MMCS), i.e., in which man (or a group) interacts with technical systems and devices in the control process. We are not dealing here with control of social and economic processes, in which man does not necessarily interact with technical systems.

In modern CS of manned flight vehicles [aircraft] (MFV), whose complexity and cost are constantly rising, man's role is increasing more and more and his duties are growing more and more complex. However, because of the limited psychophysiological and intellectual capabilities of man, he is often unable to perform all of the necessary functions for the control of complex systems and thereby lowers drastically the efficiency of these systems. Thus, according to the data of American specialists, of the total number of malfunctions occurring in the control of complex systems, 40% in the rocket industry, 63.6% in the navy and up to 70% in aviation occur because of errors made by a human operator (HO) while controlling these systems [90]. For this reason, when developing and operating modern man-machine control systems, there is a pressing need to consider human factors. In this respect, aircraft and particularly MFV CS are the first and foremost objects of scientific work on ergonomic problems of design, development and operation of MMCS.

Thus, analysis of Soviet and foreign experience in the time that has elapsed since the start of space exploration [55, 59, 110] enables us to derive the following conclusions from the standpoint of ergonomics: man can not only live in space for a long time, but perform efficiently a large volume of diversified work; the crew of manned spacecraft must participate actively in implementing the space flight program, assuring structural redundancy of onboard systems, and play the role of the adapting element in the general circuit of onboard CS; it is desirable to use man in cases where his presence aboard the spacecraft provides more effective solution of the target (multitarget) problem, as compared to machines, aids in maintaining spacecraft function on a high level of reliability and successful performance of the program as a whole, lowers the cost of running these programs, as compared to entirely automatic spacecraft (with equal effectiveness of problem solving); the designs of spacecraft and their onboard systems are such as to aid in making utmost use of man's capabilities, using the rich knowhow accumulated by aviation; the scope and importance of tasks put to man are increasing constantly, and special ergonomic studies must be pursued for them to be performed well.

There are rather detailed but often far from complete data on many traits and characteristics of the HO, which can be considered in developing various elements and equipment of MMCS. Rather extensive recommendations have been

elaborated for designing information display systems (IDS), indicators and signals; development of control levers, consoles and stations; development of life support systems and systems to maintain high levels of work capacity.

Use of already existing results of research in the fields of physiology, medicine, psychology, cybernetics, engineering psychology and ergonomics makes it possible to drastically improve the efficiency of MMCS and objects of control, often without any special industrial and economic expenditures. For example, according to O. K. Antonov [8], use of the ergonomic approach to designing aircraft cockpits, as compared to previously developed ones, resulted in 20-40% reduction of work load for the crew with regard to equipment and improved distribution thereof among crew members; it increased by 30-60% the relative time available to the crew for piloting the aircraft and scanning the surroundings [outside the aircraft], with concurrent improvement of conditions (visibility, force applied to stick, etc.); it reduced the probability of mistakes and increased reliability of work done by the crew to correct accident [emergency] situations (AS) in flight; it increased by 15-20% the operationality, readiness of the aircraft for flight by reducing the time required for the crew to make preparations and taxi to the take-off position.

In our opinion, all MMCS can be arbitrarily divided into three types (unlike the four types of operator work proposed in [54]), according to nature and degree of man's involvement in the control process. The first type refers to systems, in which man performs his functions directly, observing the object (process) of control and affecting it by his motor organs or using the most elementary equipment. In such systems (which are often called monoergatic--with one person), man's functions can be called technological and the operator could be called the technologist (according to V. P. Zinchenko [54]) or executor (according to Yu. G. Fokin [133]). The second type refers to MMCS, in which the work done by a man (or group) to control an object (process) is performed by means of controls and other means on the basis of using information models. In such systems (often called polyergatic--with several operators) the man's (group's) work is called operator work and the man is called an operator (according to B. F. Lomov [83]). We can list as this type of human work the functions of an operator-observer and operator-researcher according to the classification proposed in [54]. The third type refers to systems, in which a team of people participates in the control process, some of whom, called administrators [supervisors], do not directly interact with equipment, but are concerned with organizing operator work. Such systems are usually called organizational. In this book, we shall deal with problems referable to MMCS of only these three types.

The complexity of modern systems and, first of all, systems of purposeful control made it necessary to use the so-called systems approach and general theory of systems (GTS) to develop them.

According to current conceptions (see, for example, [78]), GTS refers to the scientific direction related to elaboration of the aggregate of philosophical, methodological, concretely scientific and applied problems of analysis and synthesis of complex systems of an arbitrary nature. GTS inherently strives

toward being interdisciplinary on the basis of creating a single scientific platform. This unity can be achieved by means of analogy (isomorphism) of processes taking place in various (engineering, biological and other) systems. Strictly demonstrative isomorphism of systems differing in nature permits "transfer" of knowledge from one discipline to another. Moreover, GTS as an area of scientific knowledge implies that it is possible to study the behavior, including purposeful behavior, of systems whatever their complexity and purpose.

The formal organization of GTS is diverse, just as the object of its study, systems. For example, the following have been developed and used in a number of Soviet works for mathematical descriptions of real complex systems: machine-algebraic methods (V. M. Glushkov [37]), test theory (S. V. Yablonskiy [147]), operator algorithms (A. P. Yershov [45]), causal networks (A. A. Markov [86]), growing machines (Ya. M. Barzdin' [9]), theory of aggregate systems and computer modeling methods (N. P. Buslenko, I. N. Kovalenko [21]), algorithmic, information and network [critical-path?] methods (G. S. Pospelov, V. A. Irikov [109]).

A. I. Kukhtenko [77, 78], who analyzed works dealing with mathematics and GTS, proposed the following classification of levels of abstract description of different systems: symbolic or linguistic (semiotics); theoretical-set ["multiple"]; abstract-algebraic; topological; logical-mathematical; theoretical-informational; dynamic; heuristic. Each of these levels has its own definition of system. Thus, according to M. Mesarovich [92], on the symbolic or linguistic level of abstract description, system refers to a set of correct statements, whereas on the theoretical-set level system is the reflection $S:X \to Y$ of abstract set X in abstract set Y, where X and Y are set of inputs and set of outputs, respectively. According to N. Burbaki [18], on the theoretical-set level, system refers to the set made up of elements that have certain properties and certain relations with one another and with elements of other sets.

V. V. Chavchanidze, who pointed to the ineffectiveness of the proposed software and absence of really common elements in the approaches of different authors, proposed a new approach [137] to the choice of a language that would describe the most fully systems and structures of arbitrary complexity. Analyzing the concepts developed in theory of artificial intelligence (AI) and using the principle of potential isomorphism of the world and cognitive intelligence, he proposed that a description be chosen in the form of concept-models directed at man and completely simulating the process of formation of concepts by a natural intelligence. Studies of the mechanism of information storage in the brain, which are presently being conducted under the guidance of V. V. Chavchanidze, revealed [138] that there are special forms of information storage by means of elements of neuron ensembles ("memorons"). This form makes it possible to issue information in the form of pictures, including some that were not presented in the learning process. Several of the works of V. V. Chavchanidze deal with validation of the need and desirability of the conceptual approach to development of GTS [139-141].

At the present time, there is a considerable number of mathematical methods for analysis and optimization (according to different criteria) of control systems

and processes, and a rather comprehensive analysis of their current status was made in, for example, [36, 72, 89, 95, 96]. In these methods, the first and foremost objective of the researcher was to completely formalize the problem, and then only to choose a criterion and develop methods of optimizing the control system or processes.

Analysis of man's performance in CS shows that the current level of development of GTS and various special mathematical methods, as well as the inadequate knowledge of psychophysiological and intellectual characteristics, and behavioral motivations of man during such activity, do not permit proposing a universal method of formalization at the present time, that would adequately describe all of these processes in the work of HO. However, the need to consider human factors led to the use for formalization of different forms of HO activity in CS, at first known methods (for example, automatic control, information theories), and then new and modified mathematical methods (theories of queueing--QT, reliability, etc.). With these methods, which make use of certain anthropometric data and psychophysiological characteristics of man, a number of ergonomic problems were solved with regard to developing controls, information display systems and even some problems of optimum distribution of functions between man and equipment. In particular, determination has been made of optimum form and arrangement of controls and consoles, illumination characteristics, form, location, means of presenting and coding information on information display systems for individual and group use, etc.

It is known that the objective of optimizing any piece of equipment is to find its parameters (analysis) and structure (synthesis) that will provide the given quality (or efficiency). As it applies to MMCS, one of the main purposes of optimization is wise (or best possible) distribution of functions between HO and equipment assuring maximum (or close to it) efficiency of the entire CS. A unified formalized apparatus is needed, which could be used to describe the main properties of an MMCS for quantitative analysis and optimization of this system.

In this book, analysis is made, on the basis of consideration of some types of HO activity in modern MMCS, of the possibility of formalizing this activity by means of mathematical and cybernetic methods. In view of the relative simplicity of obtaining base information and running algorithms of mathematical description of HO function using QT methods, an engineering method has been proposed and developed for defining the characteristics of an HO in the case of his performance with and without mistakes.

Since all MMCS parameters (including HO characteristics) can, in most cases, be divided into additive, multiplicative and logical, we have proposed here the choice of a "global" criterion of optimization in both a determined and stochastic formulation. Quantitative methods and algorithms for comparative analysis and optimization of a wide class of MMCS are offered, which are based on the use of mathematical (dynamic, linear and nonlinear) programming methods.

The main purpose of this book was to offer engineering methods and equipment for optimizing MMCS, which could increase their efficiency and improve (accelerate and lower the cost) processes of designing, developing and operating them.

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CONTENTS

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JOINT SYMPOSIUM ON BIOLOGICAL PSYCHIATRY OF USSR ACADEMY OF MEDICAL SCIENCES AND SWEDISH ACADEMY OF SCIENCES

Moscow ZHURNAL NEVROPATOLOGII I PSIKHIATRII IMENI S. S. KORSAKOVA in Russian
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[Article by A. V. Vetoshkin, Moscow]

[Text] The symposium of the USSR Academy of Medical Sciences and Swedish Royal Academy of Sciences dealing with biological psychiatry convened in Moscow from 5 to 7 May 1981. Prominent specialists in different branches of science--psychiatrists, psychopharmacologists, biochemists, biophysicists and physiologists--were among its participants.

In the 3 days that the symposium was at work, a total of 15 papers were delivered and discussed, in which Soviet and Swedish scientists submitted the results of basic research in the area of physiology and pathology of the brain, and introduction thereof into clinical psychiatry.

The opening remarks were delivered by S. S. Debov, vice-president of the USSR Academy of Medical Sciences. L. Wetterberg (head of the department of psychiatry, Karolinska Institute, Stockholm), head of the Swedish delegation, relayed the regards of the Swedish Royal Academy of Sciences to the participants and guests at the symposium.

The program of the symposium listed discussion of the following problems: biologically active substances of nerve tissue, in particular, neuropeptides, and function of receptors and membranes (1st day of the symposium); neurophysiological and genetic aspects of psychiatry (2d day); role of biological research in clinical psychiatry (3d day); in addition, questions of experimental and clinical psychopharmacology were discussed at each session.

The first session began with the overview paper by Sedwall (Sweden), which described new methodological approaches and methods for examining spinal fluid in cases of diverse mental diseases. A significant part of this paper dealt with metabolism of neuropeptides in the presence of mental disorders. Various aspects of the problem of biologically active substances of nerve tissue were discussed in the papers of Academician Ye. I. Chazov (USSR), "Some Aspects of Neuropeptide Action," Terenius (Sweden), "Endorphins in the Presence of Mental and Neurological Disorders," and A. V. Val'dman (USSR), "Neurotrophic Effects of Taftcin." The paper of Ye. I. Chazov summed up data obtained by several research teams in our country pertaining to the effects of neuropeptides on a number of vital functions,

including the functional state of the cardiovascular system. L. Terenius, who proceeded from the results of his own experimental research, offered an analysis of the literature pertaining to changes in endorphins in the presence of pathology of the nervous system and shed light on approaches (including methods) to determination of their role in function of the central nervous system and mechanisms of action. A. V. Val'dman submitted experimental data on the effects of taftcin, a tetrapentide that is the product of immunoglobulin proteolysis. He reported the results of studies having a bearing on the question of correlation between the nervous and immune systems, routes of reciprocal regulation thereof, a problem that is quite important, not only to psychiatry, but many other branches of theoretical and clinical medicine.

Questions of physiology and pathology of receptors and membranes were reflected in two papers: "Function of Central Nervous System Receptors," by S. Ross (Sweden) and "Peroxidation of Lipids--One of the Factors in Damage to Biological Membranes in Schizophrenics," by L. L. Prilipko, R. R. Lideman and A. A. Zozulya (USSR).

Neurophysiological aspects of brain function were discussed in the following papers: "Cerebral Organization of Human Emotions," by N. P. Bekhtereva, V. P. Smirnov and D. K. Kambarova (USSR); "Clinical and Neurophysiological Study of Depressive Patients," by Perris (Sweden) and K. K. Monakhov (USSR); "Experimental Models of Pathology of Caudate Nuclei. Neurophysiological and Neurochemical Mechanisms," by G. N. Kryzhanovskiy (USSR).

There was broad and comprehensive discussion at the symposium of questions of genetics of psychoses. Wetterberg (Sweden), in a paper entitled "Genetic and Biochemical Aspects of Schizophrenia," submitted the results of his many-year observations of a number of families burdened with schizophrenia, which were examined thoroughly, not only psychiatrically but for a number of biological parameters. I. V. Shakhmatova, V. M. Gindilis and V. D. Moskalenko submitted the results of mathematical processing of numerous clinical and laboratory data obtained from examining patients and their relatives, in a paper entitled "Genetic Variance Analysis of Familial and Twin Data in the Presence of Schizophrenia." Relevant comparisons were made of different clinical classifications of schizophrenia. Eberhard (Sweden) described in detail the state of the problem of psychosis in twins and his own observations.

Several papers delivered by Swedish researchers dealt with important questions of use, interaction and metabolism of a number of psychotropic pharmacological agents, their possible role in regulating behavioral reactions and therapy of psychiatric and neurological disorders: "Pharmacology of Behavior and Psychotropic Agents" (Ungerstedt), "Experimental Therapy of Zymelidinoma" (B. Ross) and "Treatment of Schizophrenia" (Bjerkenstedt).

On the last day of the symposium, there was a round table discussion chaired by Sedwall (Sweden) and M. Ye. Vartanyan (USSR) of two questions: the contribution of biological studies to clinical psychiatry; biological factors and heterogeneity of mental diseases. In addition, there was broad discussion of all topics of the symposium, its achievements and value of basic biological research to clinical psychiatry.

The active participation of scientists representing the USSR Academy of Medical Sciences--Ye. I. Chazov, A. P. Avtsyn, N. P. Bekhtereva, S. S. Debov, M. D.

Mashkovskiy, A. V. Snezhnevskiy and A. V. Val'dman--was largely instrumental in the success of this symposium.

In their closing remarks, M. Ye. Vartanyan and Wetterberg, head of the Swedish delegation, commented on the high scientific and methodological level of the papers, the good organization of the symposium and all its measures, and they expressed the hope that this meeting would aid in further development of collaboration between scientists of both countries.

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CONFERENCE OF NEUROPATHOLOGISTS AND PSYCHIATRISTS IN PERM'

Moscow ZHURNAL NEVROPATOLOGII I PSIKHIATRII IMENI S. S. KORSAKOVA in Russian
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[Article by A. A. Shutov, Perm']

[Text] An interoblast scientific and practical conference dealing with symptomatology, diagnosis and therapy of neurogenic somatic diseases was held in Perm' on 30 April to 1 July [sic] 1981. A total of 128 scientists and practicing physicians from 35 cities of the Russian Federation, Ukraine, Kazakhstan, Uzbekistan, and Kirghizia participated in the work of the conference. More than 400 practicing physicians of Permskaya Oblast were also assembled there. The participants included neurosurgeons, cardiologists, internists, endocrinologists, otolaryngologists and other specialists, due to the "synthetic" program of the conference.

A large place was occupied by papers disclosing the pathogenesis, essence and nature of somatic disturbances in patients with neuroses and individuals with borderline states. Key issues concerning neurosomatic, psychosomatic relations and mechanisms of formation of psychovegetative syndromes were raised for discussion in the papers of A. M. Veyn (Moscow), Ye. N. Panchenko et al. (Voroshilovgrad), V. A. Karlov et al. (Moscow), T. D. Bol'shakova et al. (Moscow) and others. There was broad discussion of the problem of vegetovascular dystonia. The papers of Ye. M. Burtsev et al. (Irkutsk), O. A. Kolosova (Moscow), D. D. Sozontova (Perm'), L. A. Nifontova (Moscow), L. V. Pustokhanova (Perm') and others submitted data on the neurosomatic basis of the symptom complex of vegetovascular dystonia, neurohumoral and neuroendocrine changes in patients with autonomic paroxysms, syncopic states and arterial hypotension.

A special meeting was devoted to neurogenic and other mechanisms of formation of arterial hypertension and ischemic heart disease. The papers of Z. A. Skudarnova et al. (Smolensk), A. V. Tuyev et al. (Perm'), V. F. Vinogradov (Kalinin), V. S. Movsesov et al. (Sverdlovsk), Ye. V. Vladimirskiy (Perm'), V. V. Solozhenkin (Frunze) and others disclosed concrete pathogenetic factors in formation of cardiovascular pathology. Distinctions of psychovegetative organization of patients who had suffered myocardial infarction and the role of the psychological factor in the process of rehabilitation following ischemic heart disease were the topics of A. R. Rakhimdzhanov et al. (Tashkent), A. A. Glaurov (Simferopol'), M. B. Lantsberg et al. (Perm'). The papers of A. D. Solov'yeva (Moscow), N. S. Tsimmerman et al. (Perm'), L. Ye. Smirnova (Kalinin), B. I. Kamenetskaya et al. (Moscow) and others dealt with cerebral (psychogenic) factors and mechanisms of breakdown of mediator systems in development of essential hypertension and peptic ulcer.

New data were reported at the conference on the pathogenesis of somatic disturbances associated with organic brain disease. On the basis of the results of stereotactic operations and pathohistological (morphometric in particular) studies, cerebral mechanisms of integration of autonomic functions, autonomic and somatic effects of therapeutic destruction of different brain structures, changes in the neurosecretory system of the hypothalamus and role of the limbic-reticular complex in expression of somatic pathology were demonstrated in a series of papers delivered by the staff of the Kuybyshev Clinic of Neurological Diseases and Neurosurgery (L. N. Nesterov et al.; N. N. Solovykh et al.; V. V. Skupchenko et al.; Yu. I. Kravtsov), as well as A. Yu. Makarov et al. (Leningrad). The nature of somatic disturbances was described comprehensively in the presence of brain tumors (O. V. Grinkevich et al., Sverdlovsk), epilepsy (V. I. Okladnikov, Irkutsk; V. A. Gusev, Ryazan', and others), cerebrocranial trauma and ischemic attack (B. V. Zapadnyuk, Kiev; P. V. Voloshin et al., Khar'kov, and others), hereditary ataxia (V. N. Klyuchikov et al., Yaroslavl'), syringomyelia (Ye. N. Leksin et al., Saransk) and tick-borne encephalitis (A. P. Iyerusalimskiy, Novosibirsk).

Immunological, allergological problems of epilepsy, parkinsonism and a number of other pathological states were the topics of I. G. Shabalina (Omsk), M. F. Garishina et al. (Perm') and S. K. Yevtushenko (Donetsk). Neuroendocrine aspects of cerebrocranial trauma, epilepsy, cerebral accidents and muscular diseases were discussed in the papers of A. A. Shutov et al. (Perm') and A. A. Skoromets (Leningrad). The paper of A. Yu. Ratner et al. (Kazan') called attention to the incidence and role of natal injury to the nervous system in development of somatic diseases in children and adults. There was also discussion of neurogenic mechanisms and clinical manifestations of gastrointestinal disorders (L. G. Yerokhina et al., Moscow; A. I. Loktionova, Astrakhan'), bronchopulmonary pathology (Yu. A. Kulakov, Tomsk), scleroderma (G. Ya. Vysotskiy, Semipalatinsk), sporadic goiter (M. N. Krasil'nikova, Ufa), some rare neuropathological syndromes (V. Ye. Grechko et al., Moscow; I. V. Borzenkov et al., Perm'; T. S. Osintseva, Izhevsk) and other diseases.

This conference demonstrated the increasing interest of physicians in all specialties in the problem of neurosomatic and psychosomatic pathology. It reflected a certain stage of investigation of neurosomatic correlations. The adopted resolution outlined future plans for investigation of the role of the nervous system in the genesis of somatic diseases. It was stressed that a complex approach must be used to study neurogenic somatic pathology, paying attention to cerebral (neurogenic, psychogenic), vegetovisceral, neurohumoral and neuroendocrine, as well as other mechanisms of its formation. Attention was called to the desirability of expanding, deepening and coordinating research on neurogenic somatic pathology, particularly in the area of developing new methods of treating neurosomatic disturbances. It was proposed that a unified methodological approach be elaborated, which could be used to conduct research on the problem in question, as well as to standardize the terminology, which is quite confused at the present time.

A collection of summaries of delivered papers was published, which reflected all of the material presented at the conference.

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